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SEPTEMBER

THE JOURNAL OF THE AMERICAN DENTAL ASSOCIATION

President's Address—*Bogle*
Dental Infection and Systemic Disease—*Miller*
Maximow's Research on Inflammatory Reaction—*Schour*
Malocclusion in Periodontal Lesions—*Oliver*
Modern Inlay Practice—*Irving*
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EDITORIAL
Denver Meeting

COUNCIL ON DENTAL THERAPEUTICS
Sherman L. Davis Treatment

DENTAL HEALTH EDUCATION
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President Elect of the American Dental Association

UNIV. OF MICH.

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Original Communications

PRESIDENT'S ADDRESS*

By R. BOYD BOGLE, M.D., D.D.S., Nashville, Tenn.

WHEN I assure the profession of Colorado that I personally appreciate their generous and hearty welcome, their untiring efforts in arranging for the Seventy-Second Session of the American Dental Association, I am sure I express the appreciation of the entire membership as well. From your words of cordial greeting and generous welcome, you make us feel that you are glad to have us. We want you to know that we are delighted and happy to be here.

Another milestone has been reached in the history of organized dentistry; history that abounds with every evidence of progress and accomplishments. For the future, there are increasing needs for the study and investigation of unsolved problems if we would maintain the march of progress and professional attainments. One of the great needs at the present time is a generous endowment for dental education and research.

The liberal endowments made to medical education are most commendable, and philanthropists should be encouraged to continue to give to such worthy purposes, but it is to be hoped that, in the wide distribution of funds, sincere efforts of the dental profession and the friends of dentistry will be made to enlist the interest of philanthropists in the needs of dental education and research. That dentistry fills an important rôle in the program of health service cannot be denied. The need for a definite, broader program of education and research fostered by a foundation sympathetic with the needs of dentistry, and able financially to carry it to completion, is quite apparent. This can be accomplished only by having attention brought to those philanthropically inclined regarding the value of dental service, what it has done for humanity, what it is now doing and what it will be able to do in the future

*Read before the First General Meeting of the Seventy-Second Annual Session of the American Dental Association, Denver, Colo., July 22, 1930.

if sufficient teaching and research facilities are provided with sufficient endowment to carry on. Endowments should be obtained without any handicap or impediments in its application to dental education and research. Dentistry has not been in a position to do the spectacular things that surgery has done, and when she has accomplished something worth while in the health program, it is often overshadowed or has failed to be given recognition. Dentistry working with medicine or surgery often fails to be given her just and proper recognition. That the membership of this organization is in position to be of material assistance in the educational program in this direction, there can be no question. That they will be awake to the needs of such a program and join earnestly and heartily in making such an undertaking possible is my sincere hope.

The American Dental Association is giving a broader service to the membership. The excellent JOURNAL, the official organ of the association, under the able direction of the editor, Dr. C. N. Johnson, is the outstanding dental journal published today. Each issue carries a large number of interesting and valuable contributions to dental literature. As regards the Bureau of Dental Health Education, I have often wondered if the profession as a whole appreciates or knows just what service this department is in position to render to the membership. There are available many dental health talks, moving pictures, slides, posters and similar articles to meet the requirements of almost every type of dental health meeting, or instructions in mouth health. So that when a dental health program is contemplated, this department is ready to assist for the asking. It is in position to plan for, or furnish a set-up for, a program, and it is ready to cooperate if you will only make known your needs and requirements.

Another service rendered by the Central Office is the circulation of package libraries. Many articles compiled on many subjects are available for circulation. Each package library contains information on one subject and a list of these subjects are furnished on request. These are not sold, but are lent to the membership for a period of a week, with only a borrowing charge of fifty cents. One could hardly afford to search for needed articles for such a nominal sum, but this service is maintained for the membership. Likewise, you are at liberty to use books from the library. A list of books available may be had from the Central Office.

Another activity which I wish to refer to is the insurance contract available to the members of the American Dental Association. It is most attractive, with a low premium rate, made possible by the group contract. Those whose age makes them eligible should take advantage of the opportunity. For your convenience, an insurance booth has been arranged in the exhibit hall, where you may obtain any information you may desire regarding the group insurance contract for the membership of this association.

An activity which is of interest to the membership is the work done at the Bureau of Standards. When the results of findings on casting and investment materials and other problems that have been investigated have been published, it will be of marked interest and value.

These are some of the activities of the association which reflect direct service and benefit to the membership.

May I ask your cooperation in securing recognition of a dentist on every hospital staff? From a health service point of view, this is sadly needed, and when

the opportunity presents, your cooperation will not only assist in giving our profession a just recognition, but will also make possible a needed health service for the benefit of the deserving, coming under the care of such institutions. It will also afford a contact with medicine and surgery which should be advantageous to both medicine and dentistry. The more the physician sees and knows about dental conditions, dental health and the relationship that dental infections bear to general health, the finer and more cordial and helpful will be the relationship between the two professions; which will result in a better service to those coming under our care. Consultation of the dentist and physician is to be not only desired but also encouraged, as it makes for the greater efficiency of each.

If the mouth hygiene program is to be effective in its accomplishments for good, there should be maintained in each state dental association an active, energetic group, capable of fostering a statewide program. One of the most effective ways of spreading mouth hygiene knowledge is by making contacts with public health and school officials. When the dental profession is able to convince these officials of the need of such a program and show them the end results to be obtained, it should be met with a hearty cooperation. This will open the way to the dental inspection of schools that attention may be called to any dental defects in school children, and afford an opportunity to emphasize the necessity of preventive measures.

There is a wealth of excellent contributions to the scientific sections as you will note in the program. The essayists and clinicians deserve the appreciation of the membership. I bespeak for them your loyal attendance and your courteous interest and attention to their presentations. I was interested to know whether any of the members had any suggestions to make that would be helpful to the scientific sections. Since all are vitally interested in the scientific program, I am quoting one suggestion made and ask that you give it consideration:

> Please request the membership when they attend a section to take the front seats, that those who come later will not disturb the speaker or those already absorbed in the program. Also it will, at least to a degree, keep members from walking before the lantern when in use, which is not only annoying to the speaker but disturbs the audience as well.

I am sure you will give consideration to this request coming from one of the members of this organization.

All state society organizations should be awakened to the danger that has already developed in some sections which would recognize and legalize the taking of impressions and the making of full dentures by laboratory men. If licensed, where would their activities in dental practice stop? It would be a step backward should such a thing occur, not only to professional standards but to the service rendered the public as well. Without training in the scientific and fundamental subjects of dentistry, such a group would tend to lower the standards of practice, and it would be an injustice to the men who had spent the necessary years in study and training before being allowed to take the state board examination for the right to practice.

Any influence that tends to lower recognized professional standards or any substitute for genuine professional services should challenge your loyalty to our profession in combating such evil influences and activities.

May I ask for a liberal attendance at the Second and Third general meetings?

At the Second General Meeting this evening, you will have the unusual oppor-

tunity and pleasure of hearing two essayists. One on "Drug Reform, Medical and Dental," by Dr. Paul Nicholas Leech, a subject which is engaging the attention of the profession today; the other on "Fundamental Economic Factors in Dentistry," by Dr. Henry L. Banzhaf, who has a well worth while message on this subject, dealing with a problem of vital interest to the profession. Rest assured, you cannot afford to miss this meeting. On Wednesday evening, you will have the pleasure of hearing Prof. Willis G. Sutton, and I assure you that you will miss a very enjoyable and profitable evening if you fail to attend.

With the setting of the stage complete, with the essayists and clinicians ready for the curtains to rise, with a loyal membership ready to attend and cooperate, I declare the Seventy-Second Session of the American Dental Association convened and ready to resume its labors in the interest of professional attainments and advancement and for the benefit of those whom we serve.

DENTAL INFECTION AS A CAUSE OF SYSTEMIC DISEASE*

By JOSEPH L. MILLER, M.D., Chicago, Ill.

SINCE I discussed dental infection as a cause of systemic disease with the Chicago Dental Society three or four years ago, little progress has been made in determining the rôle of dental infection in the etiology of disease. My observations would lead me to believe that more and more dental surgeons are joining the ranks of the conservative group. No carefully compiled statistics, to the best of my knowledge, have been published showing the effect on chronic arthritis of removal of "foci." We have reports, for instance, on the effect of surgical procedures on the intestine, for the purpose of relieving stasis, with reported improvement in the patient's condition. No particulars are given regarding the degree of improvement or the period over which the patient has been observed. One of the crying needs in medicine is a follow-up system which will give us information on what has happened to a patient, not a few weeks after a certain treatment has been carried out, but after a lapse of years. This applies not only to chronic arthritis, but also to exophthalmic goiter following subtotal thyroidectomy, and to peptic ulcer after surgical or medical treatment.

I shall confine my discussion largely to chronic arthritis, as this is the disease around which has largely centered the discussion on the rôle of dental infections. Its importance in a group of other diseases, such as peptic ulcer and acute and chronic nephritis, is certainly on the wane. Every physician sees patients for whom a colleague has recommended radical tooth extraction for hypertension, myocardial disease, angina pectoris, exophthalmic goiter and all types of neurasthenia.

*Read before the Illinois State Dental Society, Decatur, Ill., May 14, 1930.

Before undertaking the discussion, I might mention the results of tonsillectomy in the prevention of recurrent acute arthritis or recurrent chorea in children. A considerable number of children are subject to recurrent attacks of these two closely related diseases. Both of these ailments are frequently preceded by sore throat. There is now abundant evidence that removal of tonsils has no effect in preventing these recurrences, largely because their removal does not prevent throat infections; it only prevents further attacks of tonsillitis.

As for animal experimental work going to prove that root abscesses are the cause of chronic arthritis, only a little thought is required to show that such evidence is of little value. The patient with a chronic root abscess has probably developed a degree of immunity to the micro-organism, which has also lost some of its virulence. To inject a massive bouillon culture from such a tooth into the vein of a nonimmune rabbit and to have an acute polyarthritis develop is not evidence that this micro-organism is responsible for the patient's chronic arthritis. However, this is the proof we are asked to accept.

The only acceptable evidence that removal of teeth is beneficial in chronic arthritis is what happens to the patient after such treatment. Failure to improve, however, does not prove that the dental infection may not have been the source of the primary infection. The germs, having reached the joint, may find here a suitable soil for their multiplication and further dissemination. It is impossible, at least at present, to rule out such a sequence of events, except that we can say that certainly not all chronic arthritis is of dental origin, as we see many patients with this disease who are toothless for years before the appearance of the joint disturbance.

Recent studies have resulted in a rather definite classification of chronic arthritis into two types with different clinical manifestations and apparently of different etiology. These types are designated as atrophic and osteo-arthritic. The atrophic form is sometimes called rheumatoid arthritis or infectious arthritis. It most frequently appears before the fourth decade and is the only type of chronic arthritis found in children. It most frequently begins in fingers or toes and only later appears in the larger joints. In the fingers, it usually appears in the middle phalangeal articulation and quickly gives rise to the characteristic spindle-shaped deformity of the joint. Spontaneous recovery may take place, the deformity remaining. Its usual course is one of remissions and exacerbations, finally resulting in a high degree of atrophy, deformity and crippling.

Streptococcus viridans can be cultured from the joint, the adjacent lymph glands and the blood during the period of exacerbation. Hence, the term "infectious" arthritis is frequently employed for this type. The streptococci in the blood may come from the original focus of infection or, probably, the micro-organism from the joints gains access to the blood stream. Which of these views is correct has not been determined. It is not improbable that they reach the blood stream from the joints. If this is true, removal of the primary focus after the disease had been acquired would be of little avail. Removal of the focus of infection would then be of value as a preventive but not as a curative measure. We will return to a discussion of this question after a brief review of the second type of chronic arthritis, osteo-arthritis.

Osteo-arthritis has been defined by Timbrell Fisher, an English orthopedic surgeon and a recognized authority on chronic arthritis, as not a disease *sui generis* but a physiologic response to irritation either mechanical or toxic. Blood and joint cultures in this type up to date have been negative. Clinically, it is characterized by spur formation. Heberden's nodes are a common finding in osteo-arthritis. The most frequent location of osteophytes is the spine. They are not infrequent in the knees of fat women. The nodes on the fingers are at most only moderately painful. When the knees are involved, on account of weight bearing, there is often considerable pain on walking. The spinal osteophytes give rise to pressure root pains.

This type of arthritis is rarely found before the third decade and increases in frequency with advancing years. Osteophytes are present in the spine in at least 70 per cent of people past 50. Only a small percentage of these have symptoms or, at most, insignificant root pains.

A mechanical condition, either trauma or overuse, is an important factor in the etiology. In every occupation, the index finger is used more than the other fingers, and most frequently we find Heberden's nodes first appearing here. Osteo-arthritis of the knees is very common in fat women but is rare in thin persons. It has been observed that workmen employed at a machine which demands the excessive use of one arm frequently develop osteophytes in the wrist, elbow or shoulder of this arm; or if one leg is used to excess, osteophytes will appear in the knee. There is abundant evidence that overuse is an important factor in the etiology of this type of arthritis.

Few believe that direct invasion by bacteria plays a rôle. Fisher is of the opinion that bacterial toxin absorbed from some distant focus may be a secondary etiologic factor. He asserts, although he does not present any evidence to support his belief, that intestinal toxins may be an etiologic factor.

Patients with osteo-arthritis most frequently complain of root pains thought to be due to osteophytes in the foramen of the exit of the nerve. These pains are not continuous, but have a marked tendency to recur. The patient with brachial neuralgia due to cervical osteo-arthritis is prone to have recurrent attacks of pain in the shoulder and arm.

Attention has been called to the importance of a mechanical factor in the production of the osteophyte. Assuming that infection may play an important etiologic rôle, we could not eliminate these osteophytes by removing an infected focus. Yet I have seen more than one patient state that such root pains had disappeared after removal of an infected tooth. However, they usually came to see me later because the pain had returned. Just recently, a woman with a mild type of lumbar discomfort which had been diagnosed as arthritis related that, after extraction of a tooth, one month previous, the pain had entirely disappeared, to return immediately after she had read an account in the newspaper of a death from arthritis. The chronic invalid is easily affected through psychotherapy. Some of you may recall the throwing away of crutches and canes by the John Alexander Dowie converts.

It is my practice in these cases to explain to the patient the nature of his trouble and to assure him that this type of chronic arthritis is very rarely disabling and will probably disappear and later return; that we cannot remove the spurs on the spine; that acetylsalicylic acid will make him more comfortable while waiting for Nature to relieve the condition.

Frequently, patients will reply that since they know the disease is not crippling, they can easily tolerate the discomfort. I also advise them not to spend their money in treatments or in visiting the various springs recommended for the treatment of rheumatism.

To return to the atrophic or infectious type of chronic arthritis: This form is frequently, but not always, disabling. Rarely is there steady progression except in children. Most frequently, the disease is characterized by remissions, with an occasional case terminating spontaneously. This tendency to spontaneous remission may mislead the optimistic therapist.

After the infection has reached the joint, its dissemination to other joints may come, not from the primary focus, but from the primarily infected joint. The chronicity of the disease would then be due to the chronicity of the joint infections. If this is true, removal of the focus after the disease has developed would merely be locking the door after the horse had been stolen. Eventually, this mooted point may be settled. At present, we can only observe whether the patient is definitely benefited after removal of foci. If it can be definitely shown that removal of foci relieves these patients, we must conclude that the chronicity of the disease is due to repeated reinfections from some distant focus.

When we search the literature for evidence that removal of foci has resulted in definite improvement of the patient, we find much confusion. In most patients, a number of foci have been removed or treated, such as teeth, tonsils, sinuses, gallbladder and appendix, and it is impossible to determine in case of improvement the particular focus responsible for the infection. Our difficulties do not end here, as usually a number of different measures are carried on at the same time, such as heat, catharsis, vaccine or foreign protein therapy and various orthopedic measures. Furthermore, we meet with such statements as "slightly improved," and "greatly improved." When we recall the fluctuating course of the untreated disease, such statements are of little value. In none of the reported series have I been able to find evidence of a suitable follow-up, and it is very important to learn how the patient is getting along one, two, or three years later.

It appears probable that indefinite evidence such as the foregoing has established the belief that chronic foci of infection are responsible for chronic arthritis, rather than what appears more probable, that acute upper respiratory tract focal infections, such as sore throats, pharyngitis, rhinitis, laryngitis, sinusitis and bronchitis, are responsible. We say upper respiratory tract because this region is the abode of the streptococcus. Goldthwait and his Boston school of orthopedists believe that the intestinal tract is the most frequent source of the streptococcus responsible for chronic arthritis. Schottmuller, the German authority on sepsis, states positively that chronic root infections are innocuous. The host does not have an immunity to the invaders responsible for acute infections, nor is the virulence of the micro-organism impaired by long abode in the same soil.

The sufferers from chronic arthritis whom I see have long before had many or all of the teeth extracted. A common remark is, "I had all my teeth extracted, but I am no better"; or, frequently, "I noticed a short period of improvement following extraction of my teeth." One would surmise that, in the course of years, a physician should see at least one patient who called for some other ailment, who presented the characteristic deformity of the fingers that persists after

recovery from a chronic infectious arthritis and who ascribed his recovery to removal of infected teeth, but I have yet to see my first case.

The patient with a chronic disease fortunately harbors the belief that something can be done to relieve him of his disability. This optimism furnishes a fertile soil for psychotherapy. The physician imbued with the belief that root abscesses are responsible for many of the ills of mankind, and the physician rather than the dental surgeon is responsible for the many unfulfilled promises, may so impress the patient with his belief that faith induces the patient to say that he is better. Much of the confusion and differences of opinion in regard to various therapeutic measures in many diseases can be accounted for by the rôle played by psychotherapy. A magnetic personality obtains results by the use of a certain remedy when a different type of physician would fail; for, after all, very frequently the treatment of disease consists in keeping the patient satisfied while Nature heals.

A distinguished physician who was interested in the study of chronic arthritis told me that it had been his practice to send the patient to the hospital for the purpose of removing a lymph gland adjacent to one of the involved joints in order to make cultures. The patient was not informed of the object of this minor operation. He would tell the surgeon a few days later that since the operation, he was freer from pain than he had been for months and, in verification, would demonstrate how freely he could use the affected joint.

Recently, the Mayos have been cutting the lumbar and cervical sympathetic nerve, in selected cases of chronic infectious arthritis, with decided improvement in the patient's condition. Recently, I gave a clinic on chronic arthritis in a neighboring city. One of the patients chosen for the clinic had recently had a lumbar sympathectomy. She was enthusiastic about her improvement and said, "Just see how I can wave my arms!"

I believe teeth with abscessed roots should be removed, but I do not believe we should promise the patients that it will cure them of their complaints. I do not believe that a tooth which is merely pulpless should be extracted. It may be a very serious matter to impair the masticating surface of undernourished or enfeebled elderly patients by extracting teeth, even if some of them should show small root abscesses. Such a procedure may destroy their limited reserve and have disastrous consequences. I recently saw an elderly man, a streetcar conductor, who had had all his teeth extracted on account of indigestion. After the lapse of a year, he had been unable, for financial reasons, to obtain a plate. Needless to say, his digestion had not improved.

It is not my intention to leave the impression that root abscesses cannot be a menace to health, but rather to attempt to show that it has not been proved that they are responsible for systemic diseases, and such proof must be obtained by the clinician and not from animal experimentation.

DISCUSSION

Edward H. Hatton, Chicago, Ill.: Dr. Miller said that little progress had been made in this subject since he last read a paper on it, several years ago. And I should like to emphasize that the movement that has occurred within the groups involved has been in the same direction. Certain groups still maintain that the foundation for this theory depends upon animal experimentation; and another group, with which I have great sympathy, is inclined to believe that, after all, the proof is to be found in the clinic, and that statement is amplified by Dr. Miller when he says that results are de-

termined by what happens after the extraction of the teeth. Now as he went on to explain, he does not mean what happens to the patient tomorrow or next week, but what happens eventually and permanently. The cure that is claimed immediately is not a cure, but as he delightfully explained, is psychologic. People that are improved in this way belong to that group which many of us discovered, to our sorrow, as we practiced medicine. They are "repeaters." And I use that term advisedly. I think every surgeon has a group of patients who eventually become to him a sort of pest, because, although little by little, or piecemeal, if you please, he has removed every piece of their anatomy that is removable, usually with immediate and great beneficial effect, they continue to return to him for another and yet another operation, followed by another period of improvement, and he only gives them up when all the available structures are gone. Next, I should like to call your attention to and emphasize Dr. Miller's statement that although, in his own mind, the case was not yet proved, for focal infection, this is no excuse (I shall interpret this statement freely) for the dentist or the physician, the dentist chiefly, I think, to allow mouth infection to persist, because although it cannot be proved that this is definitely a cause of systemic trouble, it may be. This paper has dealt almost solely with the subject of arthritis. The title, perhaps, might be better stated as the "Rôle of Focal Infection in the Etiology and Treatment of Arthritis." Arthritis has always been a rather difficult disease to treat, and if any new idea seems to offer a possibility for the improvement of therapeutics in the treatment of arthritis, there are always great numbers of individual clinicians who grasp at it more or less as a drowning man grasps at a straw. He has long since run through the therapeutic possibilities of treatment of arthritis, and a new method is to him a great boon. Arthritis perhaps is a most difficult subject to discuss from the standpoint of demonstrating the value of the focal infection theory. I am sure that there are other diseases in which a study of the theory of focal infection has contributed more to therapeutics than perhaps it has in arthritis. I have the feeling that in the case of iritis, the theory of focal infection is much more plausible. At least, we will have to admit that the theory of focal infection, if not beneficial, and I certainly believe that it is, as a working theory in the treatment of iritis, has been a great benefit to the moral standing of the individual who had iritis, because in the past syphilis was the most common etiologic factor. At least it gives the patient an opportunity of coming through with clean skirts. The focal infection theory is still a working hypothesis in the treatment of disease. Personally, I believe it is more than that. Perhaps I am more optimistic than Dr. Miller, probably because I have seen fewer patients than he has seen. I observe that many of the men at least who are enthusiastic devotees of the theory of focal infection are either laboratory experimenters or men who profit largely by application of the theory of focal infection. Yet I cannot divorce myself from the opinion that there is something worth while in this theory; and although Dr. Miller says it is on the wane, it is, I believe, still a useful tool, which should not be discarded. Neither should we allow ourselves to be convinced that there is any reason for leaving vestiges of dental infection within the mouth, when it is within our power to remove them.

Herbert A. Potts, Chicago, Ill.: This subject is so broad that it is impossible to try to cover it in detail, and I hope that, from what I have to say, you will not think that I am in favor of retaining these sources of infection within the mouth, but I will make a plea for the serious consideration of the patient's condition, from the standpoint of the medical man, the patient himself and the dentist. In other words, if the remedy is going to be worse for the patient, we had better consider the patient's welfare and allow him to keep some of these teeth which possibly are infected but which show little or no absorption of bone, resultant on the infection. If such teeth, even pulpless teeth, are ruthlessly condemned even in the well individual, when the roentgenogram shows no bony absorption at all, as a prophylactic measure and for fear that the patient *will* have arthritis within the next twenty years, I deprecate it. Since Hunter, and later Mayo, suggested the mouth's being the source of many of our ills, physicians and dentists have jumped to the conclusion that pulpless teeth should be taken out, no matter whether the patient is suffering from mental aberration, indigestion or some other condition not associated with pathogenic micro-organisms. Without doubt,

people generally are in a better physical state owing to better care of their mouths because their attention has been forcibly directed to the mouth as a possible source of trouble, and they themselves have given their mouths more care than before and have visited their dentists more regularly and more frequently. It is true that more diseases are manifested in the mouth than in any other region of the body, but it is not true that the mouth is responsible for all the ills from which the other regions of the body suffer. Let us try to reason a little. We all agree that modern sanitation has saved many lives. Why not apply some of the same principles to the human mouth; and this I assume to be the first duty of the dentist. It is his duty to clean and scale the teeth properly, keeping them free from calculus. Overhanging margins of fillings are abominations and should be removed whenever found. Ill-fittings crowns create cesspools and should be removed and may be replaced, many times, by fillings or inlays; which will remedy the condition and restore the gums to a healthy state. It is probable that pyorrhea begins with gingivitis; consequently, it is logical to suppose that if the foregoing causative states, i. e., the presence of calculus, overhanging fillings and ill-fitting crowns, be eliminated and prevented, we will have less pyorrhea and therefore a healthier mouth. What might be expected as a result of pyorrhea? First, pyorrhea is a destructive inflammation of the peridental membrane accompanied by more or less pus and bacteria. From the standpoint of general health, it surely cannot be wholesome to be constantly swallowing pus and bacteria. I think it was Pasteur who said that pus itself was not the prime factor in disease, but it was the fermentation or putrefaction of it which gave rise to deleterious substances. There we have two factors, one the bacteria and the other the products of bacterial growth. These must be considered separately. What becomes of the poisons after they have been swallowed? Probably some of them are absorbed by the mucous membrane of the mouth. The rest are undoubtedly absorbed by the gastro-intestinal tract, and the result is the same as that which follows the absorption of other poisons taken in small quantities. It is obvious that we should avoid all absorption possible; consequently, it is the dentist's duty to avoid or prevent pyorrhea as far as he can by preventing gingivitis due to the three causes already mentioned. All mouths contain bacteria, most of them transient visitors, but some mouths are filthy, while some are comparatively clean. These bacteria are swallowed, but what becomes of them? A favorite way of disposing of them is to say that they are destroyed by the gastric juice; but some stomachs have no gastric juice, others have little and, in all events, it is poured into the stomach only at intervals. We have instances of bacteria, such as tubercle bacilli, being absorbed or taken into the lymph system from the gastro-intestinal tract. Why not any or all kinds of bacteria? If this is true, and it seems that it is true in some instances, why not eliminate as best we can the invader at the portal? In general surgery, we recognize the signs and symptoms of the presence of confined pus and bacteria, but as the usual pyorrheic condition presents no such signs of active inflammation, I am inclined to believe that there is only a small amount of toxin and bacteria entering the lymph stream through the pocket itself. When it does occur, we have at once local signs as well—fever, pain and leukocytosis. The other most prevalent infection at whose door the cause of many ills is laid is the one revealed in most instances by the roentgenogram and by it alone. In the vast majority of cases, these infections are hemolytic streptococci, green-producing streptococci, either in pure culture or growing together. Anyone who has had any technical experience in bacteriology knows how difficult it is to grow a pure culture and how impossible it would be to introduce such a pure culture, either of one or the other or both organisms, during the process of root canal treatment of root filling. Consequently, we must commend the dentist who sterilizes, as he does, most roots, and fills them without the introduction of bacteria; but, at times, he does not succeed and it is evidenced by an acute abscess, due to introduction of pus-producing germs. These before mentioned streptococci do not form pus, and when we have an acute abscess or even a subacute abscess, the cause is a mixed culture of bacteria. We have been lax in our nomenclature in speaking of these areas shown in the roentgenogram as a dark spot. They are, in the majority of cases, not abscesses, because they contain no pus. They are usually masses of granulation tissue, containing bacteria, it is true, but also containing leukocytes, which are alive and actively engaged in de-

stroying the bacteria. These masses of granulation tissue are reparative, and if the causative factor, the tooth, is extracted, new bone rapidly replaces the granulation tissue and healing pursues a normal course. Residual infection, when compared with the occurrence of normal repair following simple extraction, is rare indeed. I have thought for a long time that these streptococcic infections about root apices occur subsequently to the root canal filling, weeks, months or maybe years before; and as we have showers of various bacteria within the blood stream at times, it is probable that they are carried to these places, which, from the loss of the pulp with its circulation, present a localized area of lessened resistance and there find conditions favorable for their growth. Does it not seem reasonable that our various ills might be incident to these showers which infect the apical areas rather than being due to the secondary focus about the teeth? Furthermore, we are justified only in ascribing to the apical infection as the primary focus these pathologic conditions which are due to the same organisms found in the apical infection. Dr. Miller has told us that no streptococci have been cultured from or about the joints of these chronic arthritics. Consequently, we have no right to ascribe the osteo-arthritis to the teeth. I have talked recently with an eminent man who sees large numbers of cases of osteo-arthritis and he tells me that he has seen no cases which have been benefited by the extraction of infected teeth. Undoubtedly, some pathologic conditions are at times due directly to these chronically infected teeth, such as the infections of the choroid and interior of the eye. Possibly some of the infections behind a ureteral stricture may be of dental origin, and possibly some of the cases of progressive myocarditis may have a contributing cause in the teeth, but, as yet, we cannot be sure of it, and until we are reasonably sure we are not justified in removing useful teeth when, in the case at hand, it is doubtful that such removal will influence the disease from which the patient is suffering. In my practice, I try to govern my judgment and procedure by the severity of the patient's illness. If the loss of eyesight is threatened and no other cause can be found, I even remove pulpless teeth, although the roentgenogram is negative; but I do not remove pulpless teeth as a prophylactic measure fearing that the patient may at some time in the future develop an iritis. Neither do I allow a tooth or teeth bearing a large area of bony destruction to remain, but, given an individual not seriously ill, suffering from some condition which bears no pathologic relation to the organisms found in these granulomas, and having some useful pulpless teeth which, though infected, have only a small amount of bony absorption about the apices, I emphatically advise against their removal.

A REVIEW OF MAXIMOW'S RESEARCH ON INFLAMMATORY REACTION*

By ISAAC SCHOUR, B.S., D.D.S., M.S., Chicago, Ill.

THE purpose of this paper is to present before the dental profession a brief report of Maximow's researches on the cytology of inflammation. The scope of this paper is limited to his outstanding contributions, details of which are found in the papers referred to in the footnotes. Because of the limitation of time, it is not possible to discuss here in detail all of the controversial points in this field.

The scientific conception of dentistry, as contrasted with the purely mechanical aspects of this art, is continuously becoming more widespread. Dental research

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based on the biologic sciences is receiving much more recognition and attention. Among other fields of investigation, there is particular need and opportunity for further research on the inflammatory changes that occur in the dental tissues.

Orban[1] recently applied Maximow's histologic methods to the pulp and periodontal membrane and found in these tissues the same cells that Maximow had described as characteristic of the loose connective tissue. Orban also found, in the case of a chronic abscess of an upper first bicuspid, the same cell types that Maximow classified and distinguished in the inflammatory reaction of connective tissue.

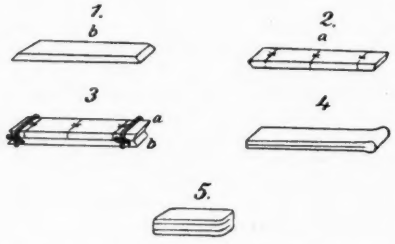

Fig. 1. — Schematic representation of foreign bodies. (After Maximow, 1902.) *1, b,* lower glass platelet of chamber for investigation with fixation and staining methods. *2, a,* upper glass platelet of chamber for investigation with fixation and staining methods. *3, a* and *b,* complete glass chamber for investigation with fixation and staining methods. *4,* glass chamber for observation in fresh condition. *5,* celloidin chamber.

The application of Maximow's experimental methods to dental tissues has not been made as yet. The insertion of aseptic and septic foreign bodies into the pulp and the soft parts of the investing tissues of the teeth, and the production in these parts of acute, subacute, and chronic inflammation, followed by careful histologic studies at various intervals, would satisfy a great lack in our knowledge of inflammation of the dental tissues.

For the sake of brevity, this review will be based primarily on Maximow's classical experiments, the first of which was published in 1902 and entitled "Experimental Investigations Concerning the Inflammatory Neoformations of Connective Tissue."[2] This work presents observations and conclusions which have been confirmed by nearly thirty years of further investigation on the part of Maximow and a number of other investigators.

RÉSUMÉ OF MAXIMOW'S FIRST MONOGRAPH[2]

In his introduction, Maximow points out that there were two extreme points of view prevalent at the close of the nineteenth century regarding the origin, significance and fate of the various cell forms that arise in the development of connective tissue during inflammation. According to one point of view, based on Cohnheim's discovery of the emigration of leukocytes and strengthened by Ziegler's glass chamber experiments, all the exudative elements of inflamed connective tissue come from the emigrated leukocytes. On the other hand, at the International Medical Congress of 1890, three essayists, Ziegler, Marchand and Grawitz, agreed, in the main, that only the preexisting connective tissue cells participate in the formation of inflammatory tissue. As in other problems, two extreme points of view were held. Maximow's

1. Orban, Balint: Contribution to the Histology of the Dental Pulp and Periodontal Membrane, with Special Reference to the Cells of "Defense" of These Tissues, J. A. D. A., 16:965 (June) 1929.

2. Maximow, Alexander: Experimentelle Untersuchungen über entzündliche Neubildung von Bindegewebe, Beitr. z. path. anat. u. z. allg. Path., Supp. 5, 1902.

chief aim in this work was to trace, by the use of cytologic methods, the fate of the histogenous and hematogenous cells in the course of the inflammatory processes.

METHODS AND MATERIAL

The animals used were rabbits, dogs and pigeons. In order to observe the newly formed tissue both in isolation and in its connection with the preexisting mother tissue, Maximow incited inflammation by the introduction of aseptic foreign bodies into the intermuscular loose connective tissue.

Foreign Bodies.—The foreign bodies were chiefly glass or celloidin chambers which were constructed so that growth would come only from certain directions and could be observed partly as in tissue culture. For observation in fresh condition on a warm stage, two glass platelets of ordinary cover-glass thickness were

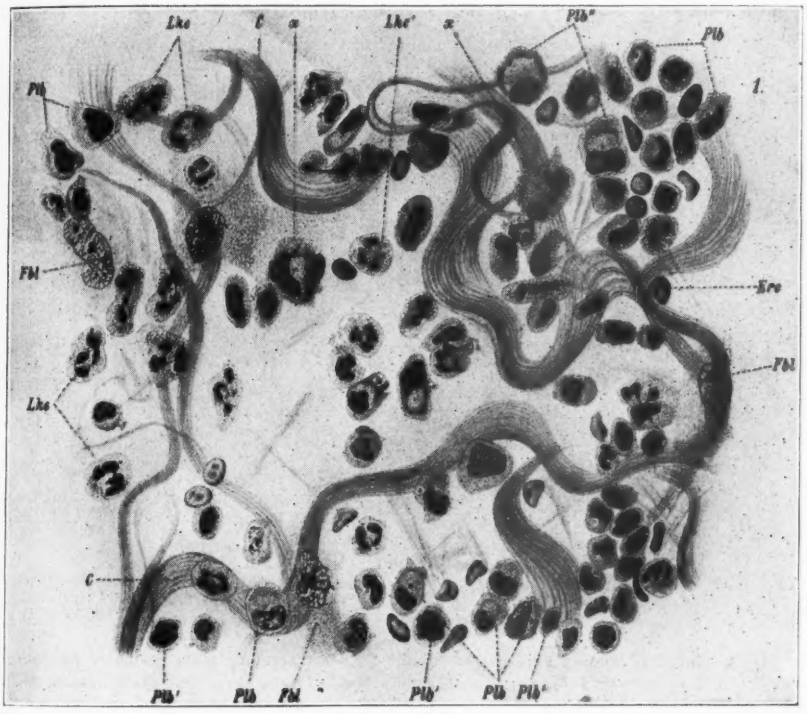

Fig. 2.—Inflamed loose connective tissue of rabbit; nineteen-hour stage of glass chamber. Four cell types can be distinguished in the edematous tissue among the collagen fibers *(C)*. *Lkc*, emigrated leukocytes; *Fbl*, fibroblasts; *Plb'*, emigrated lymphocytes; *Plb*, monocytes; *x*, mobilized resting wandering cells (histocytes). The last two cell types are still sharply distinguishable from one another, but will become transformed in later stages into polyblasts that cannot be distinguished from one another. (Zenker iron-hematoxylin; Zeiss ap. hom. imm. 2, comp. oc. 8.) (After Maximow, 1902.)

fused at one end. For investigation with fixation and staining methods, one glass plate, after being tied with strands of silk hair, was united with another one with sewing silk. The celloidin chambers were prepared by making cuts into small celloidin plates so that a space was produced that was open on three sides and offering favorable conditions to the young connective tissue. (Fig. 1.)

hours, and four, nine, fifteen, forty and sixty-five days, and the foreign bodies with the surrounding inflamed tissue were removed.

Histologic Methods.—For the histologic preparation, the fixatives were alcohol, sublimate or Zenker's solution. The stains were methylene blue, iron-hematoxylin, iron-hematoxylin van Gieson, methyl-green pyronin (Unna-Pappenheim) and hematoxylin fuchsin-S-aurantia (Dominici).

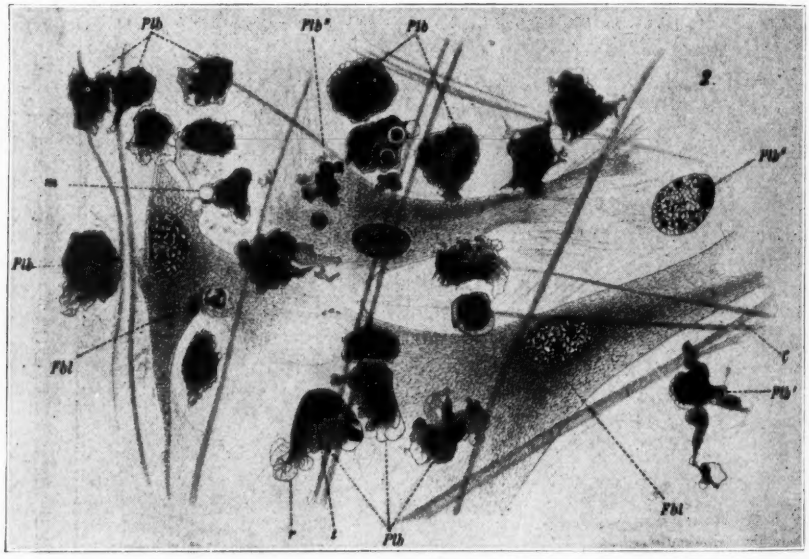

Fig. 3.—Inflamed connective tissue of rabbit; four-day stage of glass chamber. *Fbl,* fibroblasts; *Plb,* polyblasts; *Plb",* degenerating polyblasts. (Same stain and magnification as in Figure 2.) (After Maximow, 1902.)

These foreign bodies were sterilized by boiling one quarter of an hour in physiologic sodium chlorid solution, before they were introduced intermuscularly into the body of the animal. The operations were performed without narcosis, but with all precautions for asepsis. The animals were killed after intervals of nineteen

In order to compare the cell forms appearing during inflammation with those present under normal conditions, Maximow applied the histologic methods used in the study of the inflamed tissues to normal connective tissue and blood.

Normal Connective Tissue.—The normal connective tissue of the rabbit contains three chief cell forms. The best defined elements are the fibroblasts (the ordinary fixed connective tissue cells). The second cell forms are the round wandering cells. They resemble the lymphocytes very closely and most of them are lymphocytes which migrate from the blood vessels and can undergo progressive differentiation. The third cell forms present are the clasmatocytes of Ranvier or the resting wandering cells of Maximow (histocytes). (These cells are the same as the histocytes and this more convenient term will be used hereafter.) They resemble the fibroblasts but are found in smaller numbers, and their nucleus is smaller and more deeply stained. Many of these cells come from lymphocytes.

Normal Blood.—The normal blood of the rabbit includes the polymorphonuclear granular leukocytes, most of which are pseudo eosinophilic. The nongranular leukocytes include the small and large lymphocytes, and the mononuclear leukocytes.

Given this connective tissue and blood of a normal rabbit, what happens when an aseptic foreign body is introduced in-

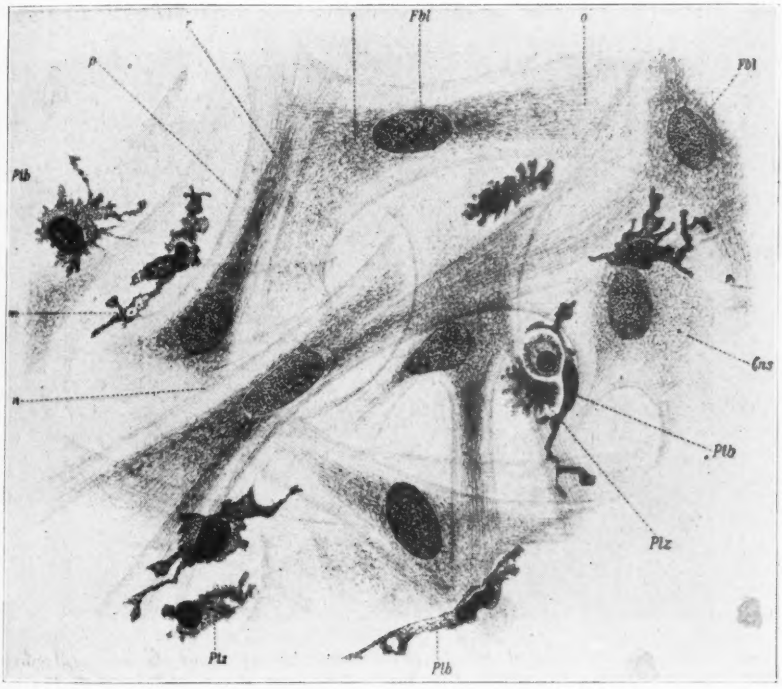

Fig. 4.—Forty-day stage of celloidin chamber in rabbit. The fibroblasts *(Fbl)* form intercellular collagenous fibers. *Plb*, sessile polyblasts in the young scar; *Plz*, plasma cells. (Iron-hematoxylin van Gieson; same magnification as in Figures 2 and 3.) (After Maximow, 1902.)

termuscularly? The following summary of the objective description of the results will be confined to the results seen in the capsule of the foreign body. The changes and transformations occurring inside the chamber are slower but do not differ much from those occurring in the capsule. Further, the results observed in the glass chamber experiment do not differ to any appreciable extent from those of the celloidin chamber experiments. In the latter, the changes occur more slowly and the experimental conditions are more favorable for the study of the relationship between the newly formed tissue and the mother tissue.

First Nineteen-Hour Stage. — The fibroblasts are at first hard to find. The tissue has become edematous. The collagenous bundles are stretched apart and some of them are torn. The number of the fibroblasts is the same as before but appears smaller because, in the edematous condition, there are less of them per unit of volume. (Fig. 2.)

The polymorphonuclear pseudo-eosinophilic leukocytes which are absent from normal loose connective tissue are present in great number. They, therefore, must have migrated from the blood vessels in response to the inflammatory irritation produced by the introduction of the foreign body, as Cohnheim observed in living tissues. These cells will from now on be called leukocytes.

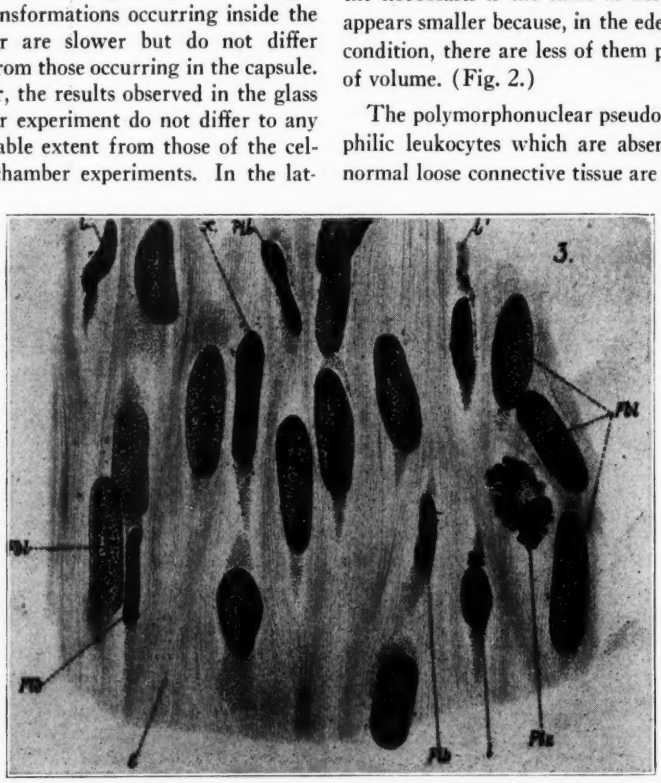

Fig. 5.—Sixty-five-day stage of celloidin chamber in rabbit. *C*, large masses of collagenous intercellular substances; *Plb*, polyblasts in scar tissue. Some of the polyblasts become transformed into fibroblast-like cells (*l*, *x*). (Zenker iron-hematoxylin van Gieson; same magnification as in Figure 4.) (After Maximow, 1902.)

The spaces of the capsular tissue are flooded with mononuclear round cells (lymphocytes). These cells could not have arisen within a few hours merely through the division of the local pre-existing cells such as the histocytes, because no mitotic figures are present in this stage. On the other hand, one can see clear pictures of migration of lymphocytes and monocytes from the blood vessels.

These lymphocytes prove to be very active and energetic. Soon after their migration, they begin to hypertrophy and character, Maximow called these mononuclear exudate cells polyblasts.

Four-Day Stage.—This stage is characterized by the intensive multiplication of the fibroblasts. The edema has subsided in most places (Fig. 3). The leukocytes are fewer in number. The polyblasts undergo further differentiation into cells which show intense ameboid movement and intense phagocytic activity. All the histocytes appear to have been transformed into the larger polyblasts. Many lymphocytes are seen migrating from the blood vessels.

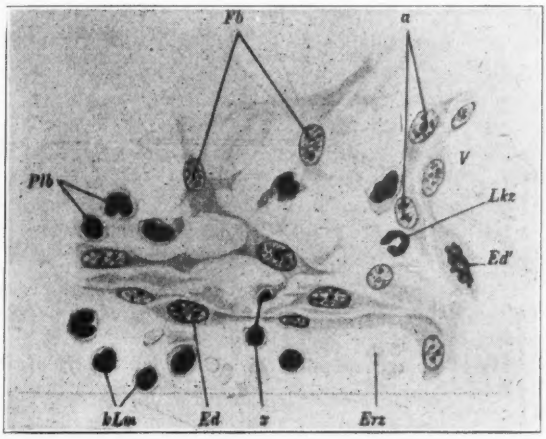

Fig. 6.—Suppurating inflamed connective tissue of rabbit, three-day stage. *V*, vessels; *Ed*, endothelial cell; *Ed'*, mitosis of endothelial cell; *Erz*, erythrocyte; *kLm*, small lymphocyte in lumen of vessel; *x*, migrating small lymphocyte; *Plb*, emigrated small lymphocytes-young polyblasts; *Fb*, fibroblasts; *a*, fibroblasts which arise from proliferating endothelial cells; *Lkz*, special leukocyte. (Zenker's stain, polychromatic, methylene blue; magnification same as in Figure 5.) (After Maximow, 1905.)

to show formation of pseudopodia. The nucleus becomes kidney-shaped, develops an indentation on one side and takes an eccentric position. Because of their ability to transform themselves into different cells characteristic of inflamed tissue and because of their highly polymorphous

Forty-Day Stage.—The fibroblasts now increase by mitosis and build the scar tissue. (Fig. 4.) The leukocytes have practically disappeared. A very few young polyblasts appear from time to time, but the old polyblasts have become permanent, sessile cells and now con-

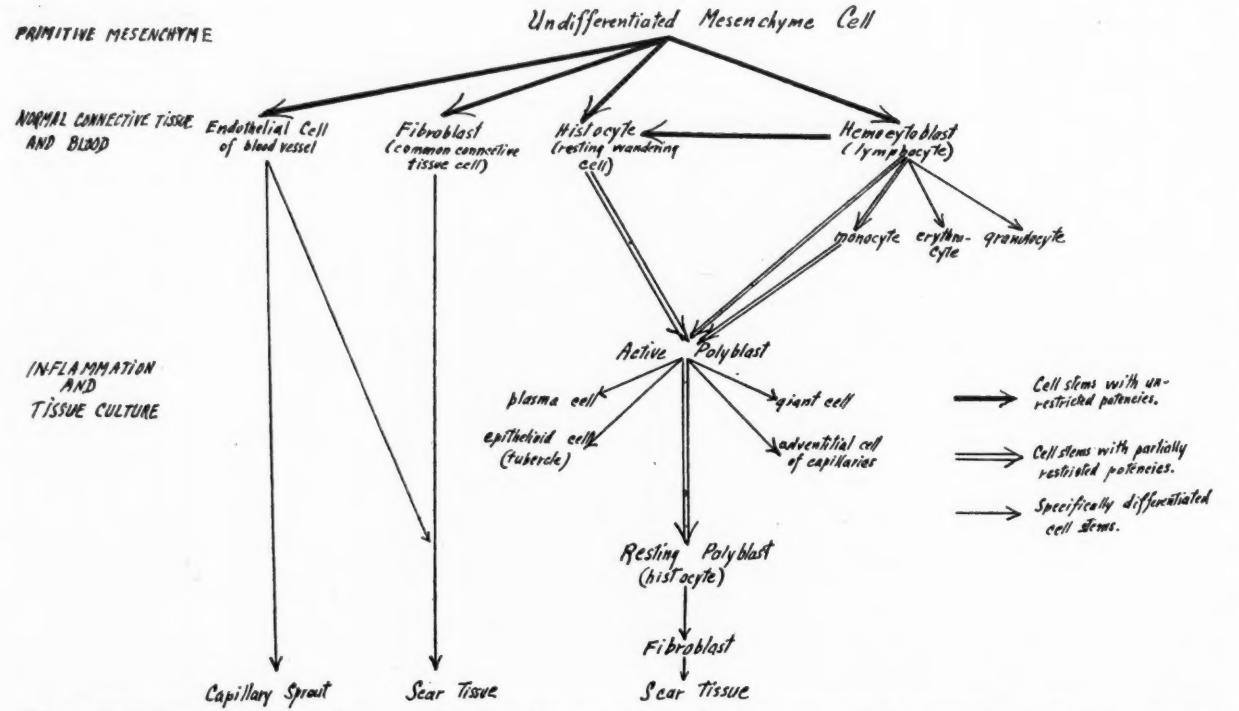

Fig. 7.—Schematic representation of the genetic relationship and the potencies of the cells present in normal connective tissue and blood and in inflammation. (After Maximow, 1924, 1927, simplified.)

stitute integral parts of the tissue. Some of these assume a close resemblance to the histocytes of the normal connective tissue, while others differentiate into plasma cells, or become adventitial cells of the capillaries.

Sixty-Five-Day Stage.—The tissue represents a true scar. The formation of intercellular collagenous (white) fibers is progressing vigorously. The polyblasts elongate and become transformed into fixed histocytes. Some of the polyblasts become modified so that they cannot be distinguished from the fibroblasts of the scar tissue. Some plasma cells are also present. (Fig. 5.)

CONCLUSIONS

The cells appearing in inflammation may be classified into three groups: leukocytes, fibroblasts and polyblasts.

The leukocytes are the first cells to appear in the inflammatory region. They probably, in some unknown manner, prepare the territory for other cell forms and withdraw in the later stages of inflammation or break down.

The fibroblasts react through proliferation and form the ground mass of the young tissue.

The histocytes transform themselves into wandering cells. Their number is not sufficient and they are aided by great masses of new young wandering cells which are produced in the adult in the blood-forming organs. These cells must be furnished with the blood as lymphocytes and must migrate from the vessels in order to get to the field of inflammation. Here they appear, together with the histocytes, as polyblasts. The latter gradually become sessile, form adventitial cells near the blood vessels and establish themselves in the young scar tissue as cells which correspond to the histocytes of the normal connective tissue, and, finally, some of them may be transformed into true fibroblasts.

MAXIMOW'S SUBSEQUENT RESEARCH ON INFLAMMATION

Following the publication of his 1902 monograph, Maximow conducted an extended series of additional experimental investigations on the histogenesis of inflamed connective tissue.

Further Experiments on Scar Formation.—In 1903, Maximow continued his experiments on the rabbit in order to answer some of the questions which arose during his previous work. He studied six to eight month stages of scar formation and found that the polyblasts remain in the scar as specialized cells which correspond to the histocytes of normal connective tissue and which are easily distinguished from the fibroblasts. The plasma cells gradually disappear.

Small celloidin chambers were inserted in the intermuscular connective tissue of new born rabbits and the reactions were studied in five hour to six month stages. It was found that the inflammatory processes and the scar formation occurred in the same manner as in the adult, but more rapidly.

Maximow also produced aseptic traumatic inflammation in celloidin chambers which had been placed in the connective tissue from two to eight months previously by piercing them with sterile needles. He found that the same cell types appear here as in the inflammation of normal connective tissue. The leukocytes emigrate from the newly formed blood vessels. The fibroblasts arise through mitosis of the fibroblasts of the scar tissue, and the polyblasts arise to a small extent from the newly emigrated lymphocytes, but chiefly from the resting polyblasts. Finally, the fibroblasts build a new scar which fills the defect

and the polyblasts again become transformed into the resting form.[3]

Inflammatory Neoformation of Connective Tissue in the White Rat.—In 1904, Maximow repeated his experiments, using the white rat. He chose this animal because its connective tissue, in contrast with that of the rabbit, is rich in mast cells and fat cells. The normal connective tissue of the rat also contains polymorphonuclear leukocytes, the nuclei of which are ring shaped.

The findings were, as a whole, the same as in the rabbit, dog and pigeon. During inflammation, the mast cells undergo only regressive changes. They break down and are absent in the new formed scar tissue.

The fat cells in inflammation become transformed in two ways, both of which involve the disappearance of fat. In some cases, especially in younger animals, the fat cell uses up its own fat and differentiates in the fibroblast direction. In other cases, especially in the older animals, the fat cell is unable to use up its stored fat. In the latter case, the polyblasts surround the cell, destroy its membrane and absorb the fat, while the freed cell body with its nucleus becomes transformed into a fibroblast.[4]

Suppurative Inflammation. — Maximow followed his experiments on aseptic inflammation with a study of septic inflammation. Using chiefly rabbits and rats, he introduced in the intermuscular connective tissue on one side of the abdominal wall a celloidin chamber which was sterilized and aseptic and on the other side a celloidin chamber which was infected with cultures of *Staphylococcus pyogenes-aureus* or *Streptococcus pyogenes.* The animals were killed at various intervals of from four hours to six months, and the tissue surrounding the celloidin chambers and the pus were examined histologically.

The reaction of the tissue in septic inflammation was found to be much more intense than in aseptic inflammation. Pictures of emigration of leukocytes and lymphocytes are accordingly readily found, especially in the earlier stages. (Fig. 6.) In the first four hours, the same three cell-types are present. The pus consists chiefly of polymorphonuclear leukocytes, which undergo various degenerative processes. The scar tissue which surrounds the suppurative focus consists of the same elements as are present in the scar tissue of aseptic inflammation, but the reaction is more rapid and the tissue is infiltrated with many leukocytes, young polyblasts and plasma cells. The absorption of the abscess takes place through large, hypertrophied polyblasts, the pus phagocytes. These cells become filled with the disintegration products of the pus corpuscles. After the pus is absorbed, most of the pus phagocytes degenerate. In the rabbit and rat, a small number of them can become resting polyblasts.[5]

Embryologic Investigation.—In order to explain the interrelationship which he found between the cells of the blood and connective tissue in inflammation, Maximow found it necessary to study the embryonic histogenesis of connective tissue and blood. Here, he found a close embryogenetic relationship between the

3. Maximow, A. A.: Weiteres über Entstehung, Struktur und Veränderungen des Narbengewebes, Beitr. z. path. anat., u. z. allg. Path., 34:153, 1903.

4. Maximow, A. A.: Ueber entzündliche Bindegewebsneubildung bei der weissen Ratte und die dabei auftretenden Veränderungen der Mastzellen und Fettzellen, Beitr. path. anat. u. z. allg. Path., 35:93, 1904.

5. Maximow, A. A.: Beiträge zur Histologie der eitrigen Entzündung, Beitr. path. anat. u. z. allg. Path., 38:301, 1905.

connective tissue cells and the blood cells, and he became one of the leaders of the unitarian theory of hemapoiesis.[6]

Tissue Culture Investigations.—As a further means of investigation, Maximow started, in 1914, to employ the tissue culture method in the study of his problems. He observed the living cultures with the aid of supravital staining and used the most refined technic in the preparation of his fixed and stained sections. At this time, Awrorow and Timofejewsky[7] had succeeded in cultivating nongranular leukocytes of human leukemic blood and found that they were transformed into polyblasts and even into fibroblast-like cells. Thus, the changes experienced by the various cells *in vitro* were found to resemble some of the phenomena seen by Maximow in inflammation. In 1922, Carrel and Ebeling[8] reported that they obtained pure cultures of mononuclear leukocytes from the buffy coat of chicken blood and observed their differentiation into fibroblast-like elements. In mammals, Maximow was able to observe the transformation of lymphocytes as well as monocytes into polyblasts, and finally into fibroblasts.[9] In order to overcome the possibility of mistaking the monocytes developing into polyblasts for lymphocytes, Bloom explanted lymph from the thoracic duct, where lymphocytes are practically the only cells present, and observed the same transformation into polyblasts and into fibroblasts.[10] Thus, the observations made by Maximow in his 1902 monograph on the potencies of the lymphocytes were confirmed experimentally by tissue culture methods.

Cultures of Endothelial Cells.—Maximow also demonstrated that the endothelial cells of the blood vessels do not develop into polyblasts in tissue culture. In some instances, they are able to turn into fibroblasts. He thus confirmed his earlier observation that the endothelial cell is a highly differentiated type.[11]

Study of Tubercle Formation.—After inoculating *in vitro* cultures of various tissues and of blood leukocytes with tubercle bacilli, Maximow was able to show that the lymphocytes and monocytes reacted by becoming transformed into typical large epithelioid cells which phagocytosed the bacteria and collected in tubercle-like cell masses. He also observed that, in the cultures of lymph node and omentum, the histocytes reacted in a similar manner. He thus showed that the epithelioid and giant cells of tuberculous lesions have the same double origin as the polyblasts in inflammation.[12]

Study of Connective Tissue Formation. — In cultures of lymphocytes and monocytes obtained from the buffy coat of centrifuged blood of the guinea-pig, Maximow not only found the trans-

6. Maximow, A. A.: Ueber die Entwicklung der Blut und Bindegewebszellen beim Säugetierembryo, Folia haematol., 4:611, 1907. Untersuchungen über Blut und Bindegewebe, Arch. f. Mikr. Anat., 73:444, 1909.

7. Awrorow, P., and Timofejewsky, A.: Kultivierungsversuche von leukämischem Blute, Virchow's Arch., 216:184, 1914.

8. Carrel, A., and Ebeling, H.: Pure Cultures of Large Mononuclear Leukocytes, J. Exper. Med., 36:365 (Oct.) 1922.

9. Maximow, A. A.: Cultures of Blood Leukocytes; from Lymphocyte and Monocyte to Connective Tissue, Arch. f. exper. Zellforsch., 5:169, 1927-1928.

10. Bloom, William: Mammalian Lymph in Tissue Culture; from Lymphocyte to Fibroblast, Arch. f. exper. Zellforsch., 5:269, 1928.

11. Maximow, A. A.: Ueber die Entwicklungsfähigkeiten der Blutleukocyten und des Blutgefässendothels bei Entzündung und in Gewebskulturen, Klin. Wchnschr., 4:1486 (July) 1925.

12. Maximow, A. A.: Rôle of Nongranular Blood Leukocytes in the Formation of the Tubercle, J. Infect. Dis., 37:418 (Nov.) 1925.

formation of these cells into fibroblasts, but also observed the intercellular formation of collagenous fibers.[13]

Trypan Blue Experiments.—His last investigation was a study of the inflammatory reaction produced by the subcutaneous injection of trypan blue in white rats. This work was done in order to check the findings in similar experiments made recently by v. Mollendorff, who, in direct denial of the observations of Maximow's school, maintains that fibroblasts are transformed into polyblasts during inflammation. In these experiments, Maximow[14] again confirmed the correctness of the observations which he had made repeatedly since 1902 to the effect that the polyblasts do not come from fibroblasts.

SUMMARY OF MAXIMOW'S CONCLUSIONS ON INFLAMMATORY REACTION

Maximow's work is the outstanding contribution to the cytology of inflammation. The following conclusions represent his results, which have been repeatedly confirmed. It must be pointed out that, while his views are not accepted by all investigators, most of the anatomists using cytologic methods agree with him.

1. The cell types present in inflammation, the leukocytes, the fibroblasts and the polyblasts, are derived from preexisting cells of the normal connective tissue and blood. For a schematic representation of the interrelationships of the cells in inflammation, the reader is referred to Figure 7, which is simplified from a chart of Maximow.[15]

2. The polymorphonuclear granular leukocytes migrate from the blood vessels and are very important in the earliest stages. They phagocytose bacteria and are thought to neutralize and detoxicate the toxins that are present.

3. The fibroblasts, in later stages, increase by mitosis of the preexisting fibroblasts and build the scar tissue.

4. The polyblasts are of both histogenous and hematogenous origin. They are derived from the histocytes of the preexisting connective tissue and from the lymphocytes and monocytes which migrate from the blood vessels. After the first few days, the hematogenous polyblasts cannot be distinguished from the histogenous ones.

5. The polyblasts appear early in inflammation and remain till the end of the process. They destroy foreign bodies such as bacteria, cleanse the tissue of cell débris and take part in the formation of the scar tissue.

6. The polyblasts may become transformed into fixed histocytes and also into fibroblasts which can form intercellular fibrous substance.

7. In tissue culture, the leukocytes, fibroblasts, and polyblasts show potencies and transformations that are identical with those shown by them in inflammation.

13. Maximow, A. A.: Development of Argyrophile and Collagenous Fibers in Tissue Cultures, Proc. Soc. Exper. Biol. Med., 25: 439, 1928.

14. Maximow, A. A.: Ueber die Histogenese der entzündlichen Reaktion. Nachprüfung der v. Möllendorffschen Trypanblauversuche, Beitr. z. path. anat. u. allg. Path., 82:1 (June 29) 1929.

15. Maximow, A. A.: Relation of Blood Cells to Connective Tissues and Endothelium, Physiol. Rev., 4:533 (Oct.) 1924. Bindegewebe und Blutbildende Gewebe, Handb. d. mikrosk. Anat. d. Menschen (edited by W. v. Möllendorff), Berlin: Julius Springer, 2:232, Part 1, 1927.

MALOCCLUSION AS A FACTOR IN PERIODONTAL LESIONS*

By OREN A. OLIVER, D.D.S., F.A.C.D., Nashville, Tenn.

THERE are various causes of periodontal lesions, among which is malocclusion. Present-day knowledge of periodontia would not let us believe that malocclusion is responsible for all periodontal conditions, but it has been demonstrated that certain malocclusal conditions do produce periodontal lesions and that such cases cannot be successfully treated unless this condition is corrected. In some of these cases, malocclusion may be only a contributing factor, and, in other cases, it may be the principle or primary etiologic condition responsible for the pathologic disturbance.

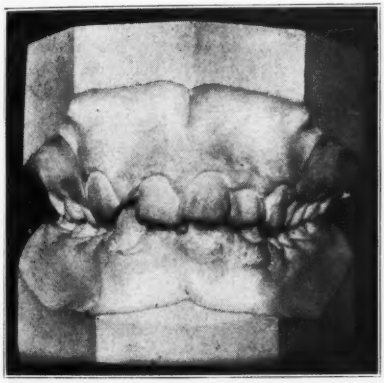

Fig. 1.—Neutroclusion with very narrow arches, in a boy, aged 13. The teeth are badly crowded in the anterior region of both maxillary and mandibular arches. The tissues surrounding the teeth are in bad condition, owing to the malocclusion of the teeth.

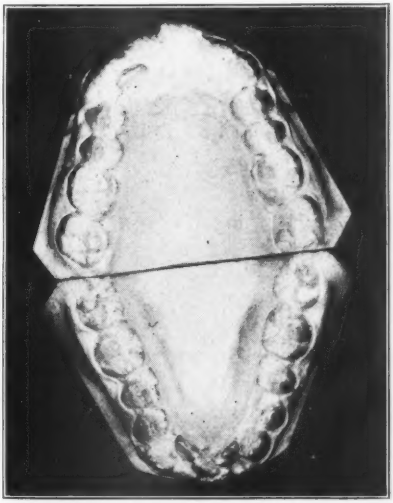

Fig. 2.—Occlusal view of case shown in Fig. 1. The condition of the tissues in both maxillary and mandibular arches is to be noted; also the position which the anterior teeth in the mandibular arch occupy and the destruction of the tissue in the maxillary arch posterior to the incisors. This case clearly demonstrated that the cause of this condition must be removed before a cure can be expected.

These malocclusal conditions, as far as etiology is concerned, act in different

*Read before the Section on Periodontia at the Seventy-First Annual Session of the American Dental Association, Washington, D. C., Oct. 9, 1929.

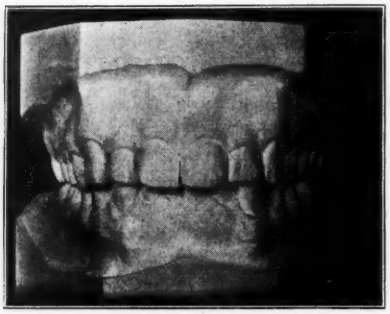

Fig. 3.—Anterior view of the completed case (Figs. 1 and 2) after orthodontic treatment.

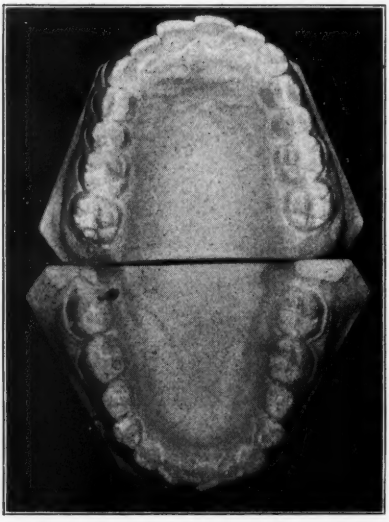

Fig. 4.—Occlusal view of case shown in Figure 3. The condition of the surrounding tissues is to be noted. This case is one that could be cured only by orthodontic treatment.

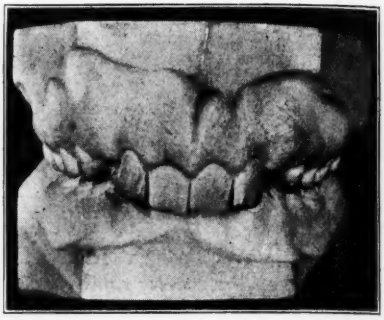

Fig. 5.—Case classified as posterior occlusion with retruding maxillary incisors, in a boy, aged 12. From the anterior aspect, the incisors of the mandibular arch cannot be seen. This case undoubtedly shows a close bite as well as a posterior occlusion.

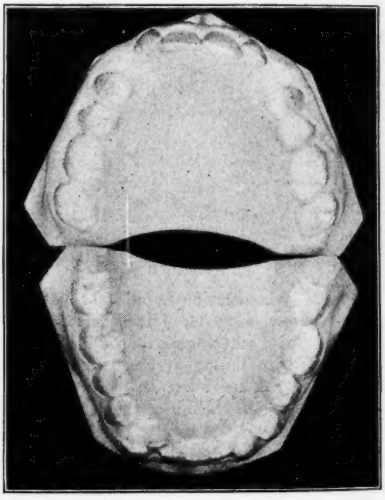

Fig. 6.—Occlusal view of case shown in Figure 5.

ways. One group throws a new stress on one or more of the teeth, producing traumatic occlusion, with resulting disturbances that are familiar to all periodontists. In another group, certain teeth are thrown out of function, and, owing to the lack of function, pathologic disturbances may occur plus the irritation of the soft tissue caused by one group of teeth coming in contact with the gingiva of the opposite group of teeth. We often find the maxillary incisors protruding

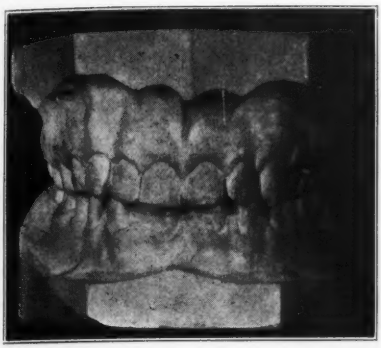

Fig. 7.—Case (Figs. 5 and 6) after orthodontic treatment. The surrounding tissue has completely healed and the bite has opened considerably in the anterior region.

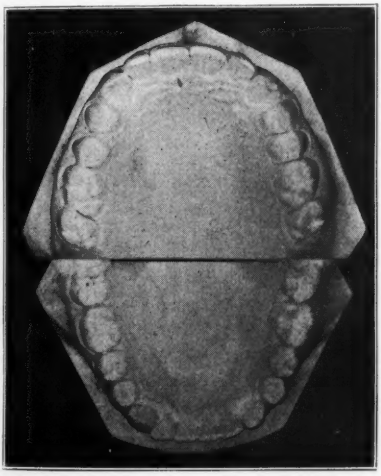

Fig. 8.—Occlusal view. The condition of the surrounding tissues in the anterior region of the maxillary and mandibular arches is to be noted. In the author's belief, this result could not have been obtained except by the orthodontic treatment that was given in this case.

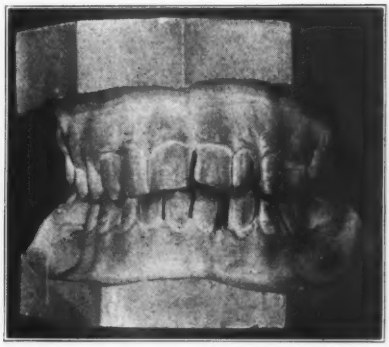

Fig. 9.—Case, in a woman, aged 28, in which the following teeth were missing: the first molar on each side of the maxillary arch, the first bicuspid on the left side of the maxillary arch, the first molar on each side of the mandibular arch and the first bicuspid on the left side of the mandibular arch. The tissues surrounding the incisors in both maxillary and mandibular arches were in bad condition. The teeth were loose. Appliances were placed on both maxillary and mandibular arches and treatment was begun.

Fig. 10.—Case after all of the spaces were closed. The tissue is in a healthy condition. During orthodontic treatment, the teeth were scaled and kept clean.

and occupying such positions that they do not have the proper occlusal function. This in itself we believe to be a factor in pathologic conditions. The lower teeth are also thrown out of function in malocclusion and strike the gingiva of

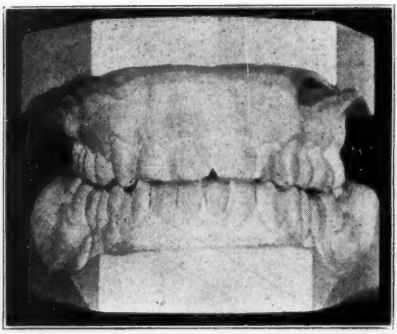

Fig. 11.—Case (Figs. 9 and 10) after completion of orthodontic treatment and replacement and reconstruction of the mouth by Dr. Redus. The teeth are in a normal condition and the tissues surrounding the anterior teeth are in a healthy condition. Examination of the teeth a year after completion of treatment shows that all of the anterior teeth are very tight.

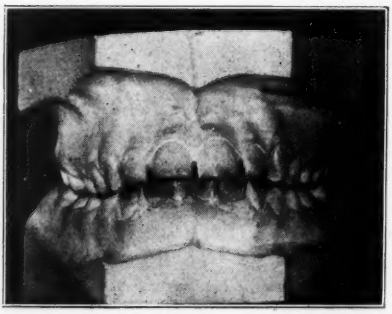

Fig. 12.—Case of a girl, aged 14, with posterior occlusion, very narrow arches, protruding anterior teeth in the maxillary arch and considerable spacing in the incisors. The anterior teeth of the mandibular arch are biting into the tissue posterior to the incisors of the maxillary arch. The tissue is badly inflamed.

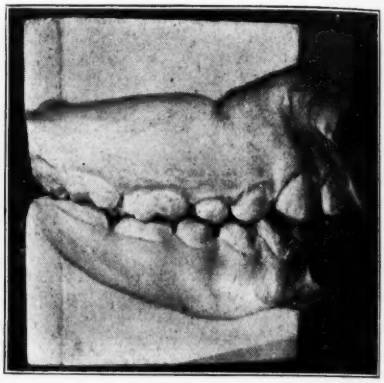

Fig. 13.—Side view of case shown in Fig. 12, giving an idea of the pronounced protrusion of the teeth in the maxillary arch.

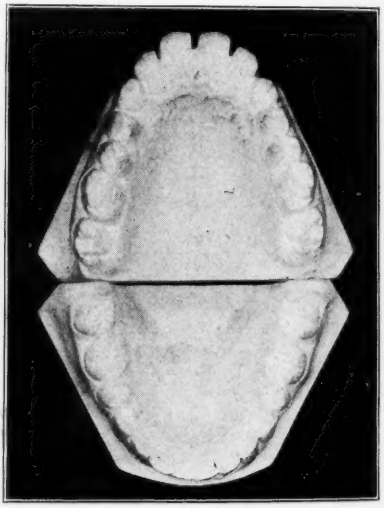

Fig. 14.—Occlusal view (Figs. 12-13), demonstrating the destruction of the tissue posterior to the incisors of the maxillary arch.

the upper teeth. This, too, contributes to the pathologic disturbance.

By the correction of malocclusion, it has been proved that the malposition of one or more teeth may be responsible for the disturbance in the supporting tissue. This is often observed in a maxillary central incisor which occupies a position lingually from the mandibular incisor, causing a function different from

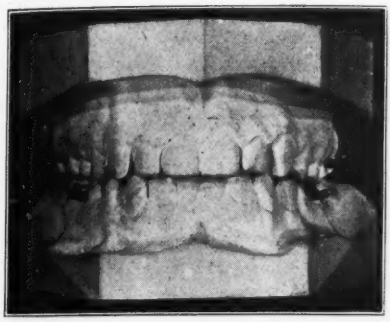

Fig. 15.—Anterior view of the case (Figs. 12-14) during orthodontic treatment. The change which has taken place in the anterior region of both maxillary and mandibular arches is evident.

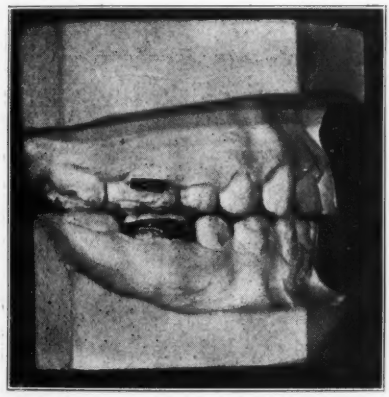

Fig. 16.—Side view of case (Figs. 12-15) while under treatment.

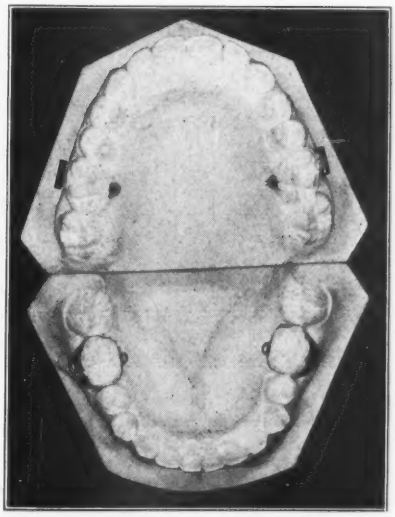

Fig. 17.—Occlusal view (Figs. 12-16). The amount of broadening out of the arches in the cuspid and bicuspid region is evident; also the healthy condition of the tissues surrounding the anterior teeth in both arches.

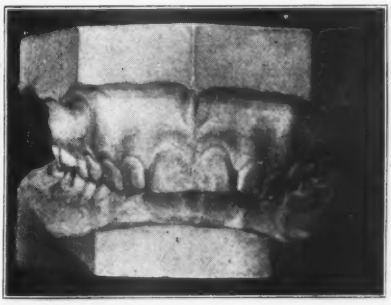

Fig. 18.—Posterior occlusion, anterior view, in a girl, aged 18. The cuspid and bicuspid region of maxillary and mandibular arches is greatly restricted; incisors in the maxillary arch protrude badly, and incisors in the mandibular arch bite deep into the tissue posterior to the incisors of the maxillary arch.

that Nature intended. We notice that, in such cases, the gingiva of the labial side of a mandibular incisor often breaks down, probably owing to improper occlusal stress and irritation from food striking the gingiva.

Other types of malocclusion, which are the result of the extraction of permanent teeth, showed marked disturbances of the periodontal tissues. These cases are produced by disturbances of the proximal contact which allow the teeth to drift into the spaces made vacant by the ex-

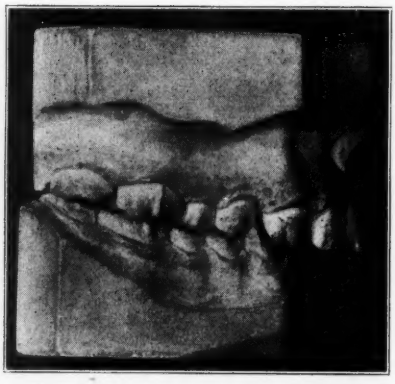

Fig. 19.—Side view (Fig. 18) of the relation of the teeth in the mandibular to the teeth in the maxillary arch.

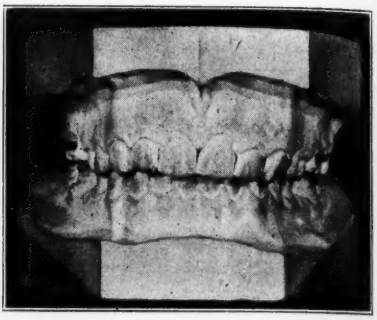

Fig. 21.—Front view of case (Figs. 18-20) while under orthodontic treatment. The condition that has developed in the anterior region of both mandibular and maxillary arches is evident.

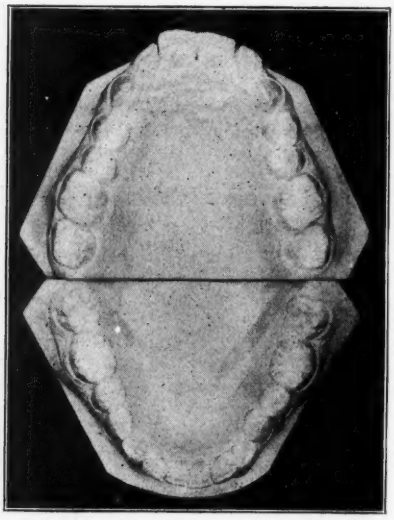

Fig. 20.—Occlusal view (Figs. 18-19) demonstrating the destruction of the tissue posterior to the incisors of the maxillary arch.

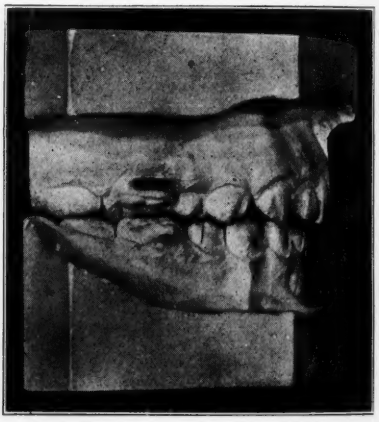

Fig. 22.—Side view of case (Figs. 18-21) while under orthodontic treatment.

traction. As a result of this drifting and tipping of the teeth on each side, the improper stress is brought to bear on the malposed teeth, which affects the supporting structure. The drifting of these teeth allows a decrease in the size of the dental arch, with the result that all of the teeth on that side are often thrown out of occlusion, traumatic occlusion of a great number of the teeth and a disturbance in the supporting tissue resulting.

In such cases, it is impossible to bring the supporting tissue back to health un-

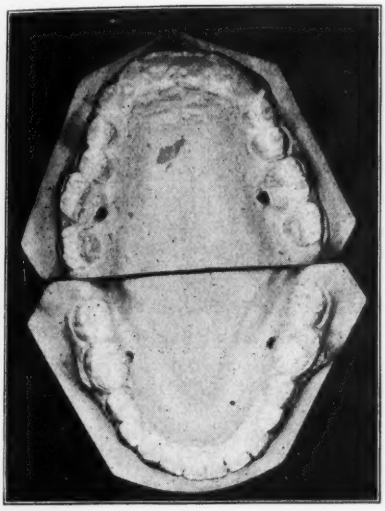

Fig. 23.—Occlusal view of patient (Figs. 18-22) while under orthodontic treatment. The amount of broadening out in the cuspid and bicuspid region in both maxillary and mandibular arches is evident.

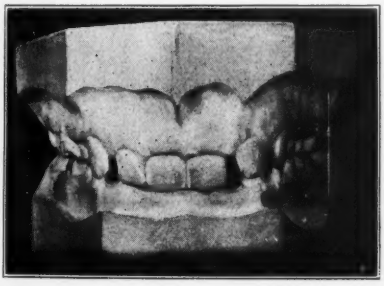

Fig. 24.—Posterior occlusion in a patient, aged 30. The anterior teeth in the maxillary arch retrude and there is spacing in the incisal region. This is a close bite and the incisors of the mandibular arch cannot be seen.

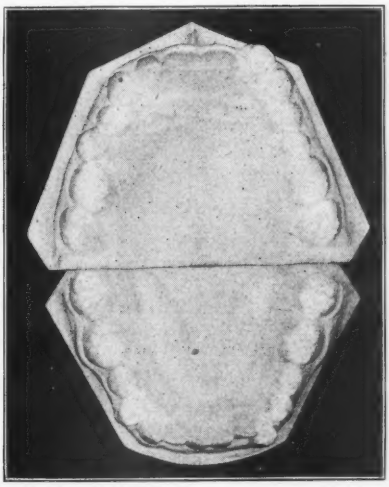

Fig. 25.—Occlusal view (Fig. 24) demonstrating the destruction of the tissue posterior to the incisors of the maxillary arch and the destruction of the tissue anterior to the incisors of the mandibular arch. The condition of the tissues in both arches anterior to the first molars is to be noted.

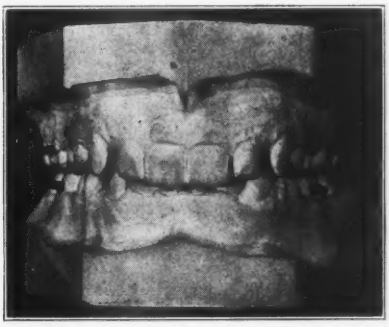

Fig. 26.—Case (Figs. 24-25) while under treatment. The bite has opened, and thus the stress on the tissues in both maxillary and mandibular arches has been relieved.

less the teeth have first been moved into proper relation to each other and the tipped teeth straightened. The question is often raised as to whether orthodontic treatment would improve the case or make it worse if many pathologic conditions have been allowed to remain for a considerable length of time. In cases not complicated by constitutional disturb-

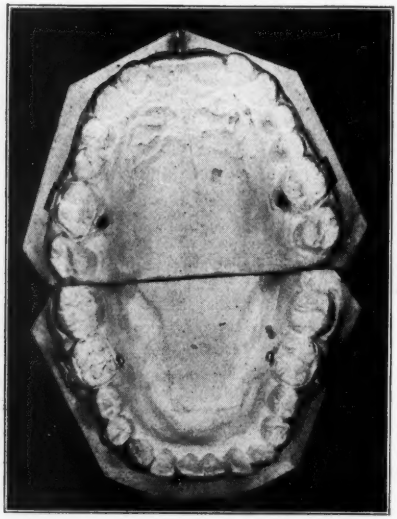

Fig. 27.—Occlusal view of the teeth (Figs. 24-26) at the present time while under orthodontic treatment.

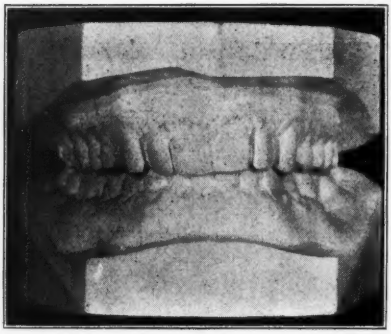

Fig. 28.—Case in which the bite was raised. The model was made after the bite was opened, about one-eighth inch, and occlusion balanced.

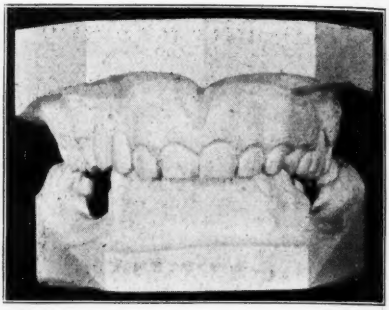

Fig. 29.—Case in a patient, aged 40, showing relation of the teeth of the mandibular arch to the teeth in the maxillary arch and the loss of the molars on each side in the mandibular arch, as well as loss of first molars on each side in the maxillary arch. These teeth have been replaced by a bridge in the maxillary arch, this bridge being later removed and replaced with a more satisfactory one.

Fig. 30.—Case (Fig. 29) after complete reconstruction in the upper and lower arches. The amount that the bite has opened is to be noted. (Case of Dr. Fred H. Hall.)

ances, the experience of most orthodontists is that orthodontic treatment tends to relieve the pathologic condition. We believe that the dental stimulation necessary to produce proper cell metabolism in the surrounding tissue of the teeth so that movement will take place also is a factor in sending blood to the parts, and thus repairing the broken down tissue and eliminating any infection that may be present.

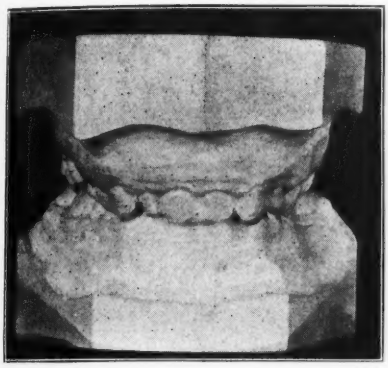

Fig. 31.—Case presented for pyorrhea treatment. On a careful clinical examination with x-ray diagnosis, it was found that three molars above and below were carrying the entire stress of the mouth. This patient was suffering with a neuralgic condition in the trifacial division, and impaired hearing, and was very nervous. There was a considerable amount of trauma in the molar region. The bicuspids had worn until they were out of occlusion, which left only the posterior teeth to carry the entire stress of the mouth. The bite was raised, and all the teeth put in occlusion, with the result that much of the nervousness and neuralgia was eliminated and a marked improvement in the hearing was reported by the patient.

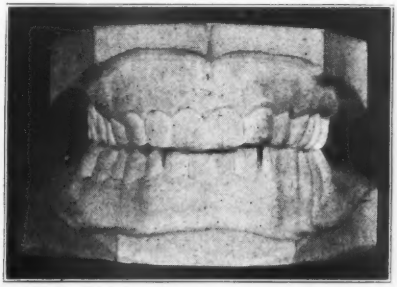

Fig. 32.—Case (Fig. 31) a year after completion. There was little treatment of the pyorrheal condition. The posterior teeth are tightening, and the tissues of the entire mouth have taken on a healthy appearance. (Case of Dr. C. W. Hoffer.)

The accompanying illustrations demonstrate the types of cases which can be successfully handled by the orthodontist. A number of cases from my practice are shown, with the methods used, and the results obtained in cooperation with other men.

I have endeavored to bring to your attention certain types of cases in which orthodontia can be of great value to both younger and older patients. In older patients, it is necessary for certain reconstruction work to be carried out in order to eliminate the cause and correct the condition of the occlusion and the surrounding structures.

A SYSTEM OF CAVITY PREPARATION WHICH MEETS THE REQUIREMENTS OF MODERN INLAY PRACTICE*

By ALBERT JOHN IRVING, D.D.S., New York City

ALMOST from the very beginning of dentistry as a profession, it was observed that carelessly prepared cavities, and deeply inserted metallic fillings, would frequently promote degenerative changes and often cause partial or complete breaking down of the pulp.

The mere loss of the pulp seemed of so little importance after the tooth had reached the age when it was fully formed, and not until it had been adequately demonstrated that pulpless teeth in some instances were the direct cause of secondary infection did the dental pulp receive some consideration. Consideration of the pulpless tooth as a possible focus of infection had a marked influence on the trend of partial denture and bridge prosthesis. Instead of pulp being removed to accommodate certain attachments, many new types of so-called live tooth attachments were designed and employed. In operative dentistry, the pulpless tooth question had little effect as far as the filling of teeth was concerned, and cavities were prepared in much the same way as before.

It was not until recently, when Rickert,[1] Henrici and Hartzell,[2] Thoma[3] and others brought to light a new menace, namely, metastatic infections arising from vital but degenerated pulps, that a cry was raised in the ranks of operative dentists for a revision of cavity form for the gold inlay based upon protection of the pulp, and a plea was made for a more conservative attitude in the preparation of teeth for filling.

The G. V. Black[4] system of cavity preparation is undoubtedly the most widely known, and at one time it was almost universally accepted. Before teaching it as a system, Dr. Black made an exhaustive study of the crushing strength of filling materials and of the enamel and dentin. On the basis of these findings, he designed a cavity (Fig. 1) which would provide sufficient resistance and a retention form compatible with the crushing strength of the filling material used. Even though Dr. Black designed this cavity for gold foil and amalgam,

*Read before the Section on Operative Dentistry, Materia Medica and Therapeutics at the Seventy-First Annual Session of the American Dental Association, Washington, D. C., Oct. 10, 1929.

1. Rickert, U. G.: Dent. Cosmos, 67: 635 (July) 1925; Clinical Significance of Infected Degenerating Pulp, J. A. D. A., 14: 1895 (Oct.) 1927.

2. Henrici, A. T., and Hartzell, T. B.: J. Dent. Res., 9: 419, 1929.

3. Thoma, K. H.: J. Dent. Res., 8: 529 (Aug.) 1928.

4. Black, G. V.: Operative Dentistry, Ed. 6, Chicago: Medico-Dental Publishing Co.

J. V. Conzett[5] and R. H. Volland state, in discussing cavity preparation for the gold inlay, that "fundamentally the principles of cavity preparation are the same, no matter what may be the material with which the cavity is to be filled."

M. L. Ward[6] has clearly demonstrated the difficulties which arise in attempting to fit an inlay casting into a mesioclusodistal cavity of the Black type. He advocates a hopper-type cavity for the gold inlay, all walls of which taper from 5 to 20 per cent per inch (Fig. 2).

Fig. 1.—Model of a mesioclusal cavity in a maxillary first molar prepared for a gold inlay according to Black's teaching. All walls are prepared parallel and the bevel of the cavosurface angle is continuous.

Fig. 2.—The same cavity as in Figure 1, prepared for a gold inlay according to Ward's teaching. It is a hopper type preparation, all walls of which have a taper of approximately 5 per cent per inch. The only bevels occur at the axiopulpal angle and at the cervical cavosurface angle.

The slice preparation, first suggested by M. L. Rhein, was at once severely criticized because too much sound tooth tissue was needlessly sacrificed. H. W. Gillett[7] demonstrated with photomicrographs of cross-sections which Dr. Black had made of his cavity that far less sound tooth structure is removed when the slice preparation is used than when boxlike cavities are employed. Dr. Gillett also perfected the technic for preparing slice cavities and developed it into a definite system (Fig. 3).

We have always assumed that the dental cements are poor conductors in thermal changes as compared with gold and amalgam, but no scientific evidence was available until in the winter of 1926, when the Bureau of Standards, through the efforts and under the direction of Dr. Gillett, conducted a series of tests on temperature measurements of tooth specimens. The cements tested were zinc oxy-

5. Conzett, J. V., and Volland, R. H., in American Text Book of Operative Dentistry, Philadelphia: Lea and Febiger, 1926; p. 382.

6. Ward, M. L. (Editor): American Text Book of Operative Dentistry, Philadelphia: Lea & Febiger, 1926; p. 415.

7. Gillett, H. W., and Irving, A. J.: Dent. Items Int., 49: 669 (Sept.), 765 (Oct.), 853 (Nov.), 943 (Dec.) 1927; 50: 1 (Jan.), 83 (Feb.), 167 (March), 253 (April), 339 (May), 421 (June), 499 (July), 607 (Aug.), 681 (Sept.), 759 (Oct.), 839 (Nov.), 926 (Dec.) 1928; 1929.

phosphates. The Bureau's report states: "The conductivity of pure gold is about 600 times that of the cement tested. In general, however, gold alloys have considerably lower thermal conductivity than the pure metal." Further measurement of the thermal conductivity of dental cements appears to be unnecessary, at least as far as the applicability of the results to dental practice is concerned. The whole point is that the conductivity of inlay alloys is a few hundred times that of cement. Whether the factor is 200 or 400 is of no particular importance since it is not possible to make numerical calculations applying to the question of thermal shock.

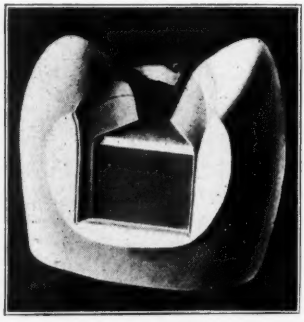

Fig. 3.—Model of a maxillary bicuspid with a distoclusal cavity prepared by Dr. Gillett by the slice method of cavity preparation.

In view of the need for advocating a conservative position in all fields of dental activity where mechanical devices are used, and the need for introducing into the tooth a material with which it will be compatible, it would seem that the thin, or shallow, inlay, or the cement filling overlaid with a thin inlay, is ideal as far as pulpal protection is concerned. The thinner the inlay, the more easily it will stretch, or flow, under the forces of occlusion, and when this condition arises, it always causes dislodgment.

Various methods have been advocated to overcome the stretching of thin inlays while under stress, the principal method being that of using harder and tougher golds. Up to a certain point in the alloying of inlay golds, this hardness is to be desired; but, beyond this point, the gold reaches a state where it is not sufficiently malleable to permit the spinning of inlay margins to contact with the enamel surfaces of the tooth.

Prior to the introduction of the gold inlay, the porcelain inlay had been in use for some years. It was routine for many operators, in preparing cavities for porcelain inlays, to make grooves or channels into the walls of the cavity wherever possible. Quoting from a letter written by W. E. Taggart to R. Ottolengui[8] in

Fig. 4.—Model of a mesioclusal slice cavity in a maxillary first molar prepared for a gold inlay by J. J. Travis. The deeper portions of the cavity are filled with cement in which a single groove on the approximal aspect is cut. The slice cut terminates in a narrow shoulder at the cervical aspect.

8. Ottolengui, Roderique: Table Talks on Dentistry, Brooklyn: Dental Items of Interest Publishing Co., 1926; p. 312.

1920 concerning gold inlays: "To begin with, the inlay must fit a well prepared cavity which has grooves so placed that the inlay while sliding into its seat, cannot be sprung or pushed away from the cavity wall, since it is this springing away which is practically the cause of the well-defined cement line at the buccal and lingual margins and the so-called lack of fit at the gingival border."

In commenting on this statement, Dr. Ottolengui says: "Two points here made by Dr. Taggart should be emphasized; they should be emphasized because, though told to us long ago by Dr. Taggart, they have been more or less ignored even by his most ardent followers: These two points are, first, that there should be grooves in every cavity prepared for the reception of a gold inlay; secondly, that the cement is not employed as a cementing medium, but as a wedging agent."

Recently, several cavity forms utilizing grooves have been suggested. J. J. Travis[9] suggests a cavity preparation in which the entire cavity is filled with cement and a slice cut is made which terminates in a cervical shoulder. In this preparation, the occlusal portion is cut as wide as the Black or Ward cavity, and a single channel is cut in the cement on the proximal side (Fig. 4).

K. W. Knapp[10] has also suggested a similar cavity. The slice cut is made in the usual way, and a lock form of retention replaces the single groove which Travis suggests (Fig. 5).

In describing the cavity preparation which I am about to present, I shall use the term "channel slice preparation," since this seems to be a satisfactory one for identifying it and likewise inoffensive

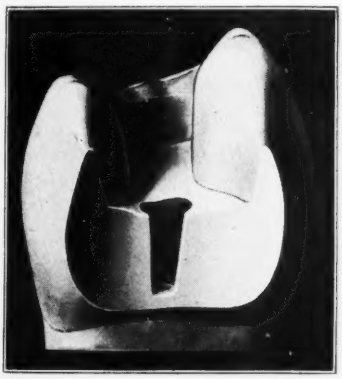

Fig. 5.—Model of a cavity in a plaster model prepared by K. W. Knapp. This preparation is recommended by Dr. Knapp for use as a bridge abutment for sound teeth.

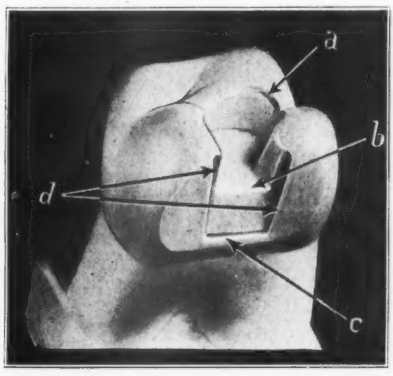

Fig. 6.—Model of a cavity prepared for a gold inlay by the channel slice system. The proximal contour is reduced to a flat surface and all walls are tapered as in the Ward cavity. The occlusal cavosurface angle *a*, the axiopulpal angle *b* and the gingival-slice angle *c* are beveled. A lock form of retention is provided by the two diverging channels *d*.

9. Travis, J. J.: Dent. Cosmos, 67: 1141 (Dec.) 1925.

10. Knapp, K. W.: Modern Conception of Proper Bridge Attachments for Vital Teeth, J. A. D. A., 14: 1027 (June) 1927.

to anyone else who may be working in the same field. It is also a satisfaction to know that I am not confronted with the need for introducing a new principle but merely with the task of correlating a recognized but inadequately used principle in cavity preparation technic.

The channel slice system of preparing step cavities was not evolved merely as a means to overcome the stretching and subsequent dislodgment of thin inlays when cast with a semihard gold, but was developed into a system, because, with it, cavities can be more easily and more quickly prepared, and because it lends itself so well to the making of inlays

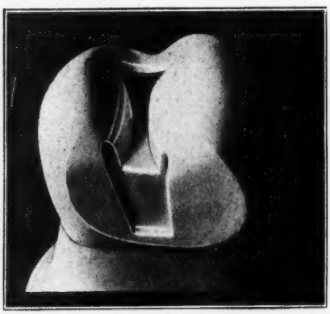

Fig. 7.—Model of a mesioclusal cavity prepared by the channel slice system for a case of little carious involvement of the occlusal and approximal surfaces. The channel walls in this case lock the inlay at those points, which makes it unnecessary to further widen the occlusal and approximal portions in order to prevent stretching of the gold and subsequent dislodgment.

when the indirect system is employed. Although haste at the expense of an adequate preparation is to be deplored, the time consumed is important to both patient and operator, and any procedure likely to aid in the production of good inlays in less time should receive consideration.

In this preparation (Fig. 6) as in all slice preparations, the approximal surfaced is disked until flat or slightly concave. All walls taper approximately 5 to 20 per cent per inch, as Ward suggests, with a bevel of the occlusal cavosurface angle (*a*) which will permit the spinning of the inlay margin to contact without endangering the margins of the amalgam model and the enamel margin of the cavity. It is for this reason that the enamel margins are beveled and not for the protection of short enamel rods against cleavage while the tooth and inlays are under biting stress. As Dr. Ward suggests, when the walls of a cavity are tapered as much as from 5 to 20 per cent per inch, all short enamel rods are cut

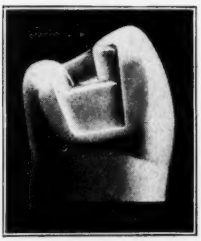

Fig. 8.—Model of a case similar to that in Figure 7 except that the occlusal and approximal steps are widened to accommodate a case of greater carious involvement.

off, making it unnecessary to further bevel the cavosurface angle.

The angle (*b*) formed by the pulpal and axial walls is also beveled, as well as the angle (*c*) formed by the gingival wall, and the slice cut for the reason that, when gold is thrown against a sharp corner in the investment, either the corner is knocked off or the contraction of the metal in cooling so attenuates the investment at this point that a rounded surface results instead of a sharp angle; which makes for an ill-fitting inlay at this point.

The channel walls (*d*) are provided with and are largely made up of tapering grooves or channels which diverge slightly. This divergence is in direct ratio to the depth of the cavity from occlusal surface to cervical margin. The deeper this part of the cavity is, the greater the divergence, and, in extremely shallow cavities, this divergence is so slight that it approaches parallelism, to facilitate the fitting of the cast inlay in the cavity and to provide for the maximum retentive power.

These channel walls offer great resistance to the stretching of the inlay at the occlusal isthmus, especially if this

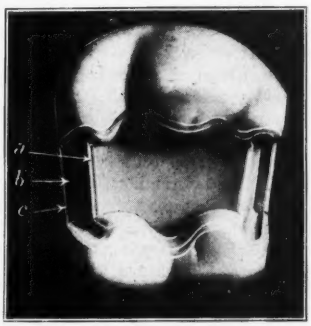

Fig. 9.—Occlusal aspect of a model of a mesioclusodistal cavity in a mandibular molar prepared for a gold inlay by the channel slice system. *a* represents the bevel of the axiopulpal angle; *b*, the inward incline of the gingival wall, and *c*, the bevel of the gingival slice angle.

isthmus is narrow, as it may be when prepared for a case with little or no occlusal caries (Figs. 7 and 8). The channels also facilitate the seating of the inlay, since it slides into the cavity guided by the channels. If the inlay is locked into its seat in this way, there is little likelihood of any tendency for the inlay to move proximally. The width of the proximal portion or the distance between the channel walls is, therefore, entirely dependent on the carious involvement.

When it is necessary to secure the maximum of protection against stretching of the inlay, and its subsequent dislodgment, an additional precautionary measure is taken. The cervical floor is inclined slightly cervically as it approaches the axial wall; which provides for an additional lock and retentive form.

In all cavity preparations other than the slice cavities, almost all of the inlay lies within the confines of the cavity walls. The inlay in such cavities frequently acts as a wedge, which may be a factor in the fracture of a tooth or a

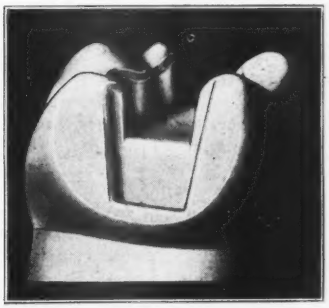

Fig. 10.—Approximal aspect of the model shown in Figure 9.

cusp. It should be noted in the slice forms of cavities that more of the inlay lies beyond the confines of the cavity walls, and in mesioclusodistal preparations (Figs. 9 and 10), the resulting flaps of gold embrace the sides of the tooth much as a partial crown does, thereby minimizing the danger of fracture. In bridgework where this danger is enhanced by the additional strain and torque when a pontic is attached to an inlay, the advantages of these flaps of gold, made possible by the slice cut, can be readily appreciated. Another advantage in bridgework is that the broad sur-

face of gold provides excellent facilities for soldering since there is little danger of attaching the pontic at or near the inlay margin.

With all the distinct advantages which the channel slice cavity possesses, the least amount of cutting is necessary and the minimum of sound tooth structure removed.

2 East Fifty-Fourth Street.

DISCUSSION

H. H. Streett, Baltimore, Md.: The extensive use of cast fillings and attachments for the various types of restorations now being used demands a thorough knowledge of tooth anatomy and study of cavity preparation in order that sufficient strength may be obtained to withstand the stress of mastication without injury to vital pulps. It is generally accepted that metastatic infection may arise from degenerated vital pulps as well as secondary infection from periapically infected teeth. Therefore, it is necessary that we give more consideration to the preservation of pulps of teeth to prevent endangering the patient's general health. Dr. Irving has presented various types of cavity preparation, demonstrating the importance of a standard technic by which the required strength may be obtained with minimum loss of normal tooth structure. After studying the paper, I am convinced that his two foremost thoughts are the protection of vital healthy pulps and preparation for the filling or attachment which will ensure sufficient strength to meet the requirements of the case. In oral examination, we find many pulpless teeth with no apparent treatment of the root canals, roentgenograms of which reveal structural change about the apices, a condition which is always considered as offering a possible focus of infection. Many such cases are directly traceable to pulp irritation immediately following placement of fillings; either from thermal shock due to the conductibility of the metal or traumatic injury following cavity preparation. This, in many instances, may be prevented by the use of the technic as presented by Dr. Irving. The advantages of the channel slice system of cavity preparation are: less cutting of normal tooth structure; the double groove, permitting more accurate seating, the filling being guided in one direction only; added strength; extension of the filling beyond the point of recurrent decay and a surface sufficient for the attachment of ponties when necessary without endangering the margins. The technic outlined, with slight variations, has been used for a number of years by me with very satisfactory results. Dr. Irving mentions stretching of gold and subsequent displacement of fillings, which may occur with the extremely thin casting unless precautions are taken. In the type of casting in which this may occur by enlarging the channels and using the kind of gold indicated, this has been overcome to a great extent, and this, I think, is due to the added quantity of the gold, necessitated by enlargment of the channels. When the casting is to be used for an abutment, it is necessary to extend the slice in order that sufficient strength may be obtained to prevent stretching of the gold or pulling away from cavity margins. Dr. Irving has mentioned the advantages of the channel slice preparation in the indirect method of casting. As good results are possible by the direct method. The various steps in cavity preparation have been outlined, and it is necessary to follow each one carefully if desired results are to be expected. In enumerating the different types of cavity preparation, Dr. Irving has clearly demonstrated to me the advantages of the channel slice system of cavity preparation over other types presented. In some instances, the amount of gold necessarily exposed is an objection, but this should not be given consideration, if lasting results are to be secured. I wish again to emphasize the importance of pulp protection in cavity preparation. This can best be obtained by a technic which requires the least amount of tooth cutting and the use of a minimum amount of metal, as has been clearly demonstrated.

Emory O. West, Des Moines, Iowa: Dr. Irving has again brought to our attention one of the most important problems that the operative dentist is confronted with today, principally, conservation of tooth structure in cavity preparation. Dr. Irving should be greatly commended on his stand in this particular phase of dentistry. Frequently, it is brought to our attention that deep-seated metallic restorations cause degenerative changes in the pulp tissues. No doubt, in many instances, this is due to careless cavity preparation. In other instances, it may be due to general systemic disturbances. Failure to

remove all caries is almost sure to cause the death of the pulp, and no doubt more pulps become degenerative from this cause than from thermal shock from the metallic fillings. I well appreciate Dr. Irving's ability as a teacher on cavity preparation and as a casting expert, and, in his practice, no doubt the channel slice preparation proves very successful. As has been stated by other writers, the slice cavity preparation may be a short-cut method for the careless operator, and a high percentage of failures will result. From Dr. Irving's explanation of this type of a cavity for gold inlays, it seems that it would be especially well adapted for teeth that show no caries or very inextensive proximal caries. The average operator sees the case presenting approximal caries, some extensive, some inextensive, and, in a great many cases, when the caries is removed, it is necessary to protect the pulp with a cement wall. In placing a cement base in order to use the slice cavity preparation, unless it be a modified preparation, we have no gingival wall to resist stress on the approximal portion of the inlay. Would it not be better to have a gingival wall on solid dentin and the axial wall of cement, which would furnish the same protection to the pulp? If channels are cut in the cement, they offer little resistance for the approximal portion of the inlay. If the channels can be placed in sound dentin, the slice preparation has a much better foundation. In this type of cavity, it is necessary to use a hard gold so there will be no flowing of the gold when heavy stress is exerted. Is it well for us to use a hard gold throughout the mouth in the various types of restorations? Twenty-two carat gold seems to wear in proportion with the enamel of the tooth. It is only justice to the patient that we consider this from the point of view of traumatic interference. In the making of castings, it is not so difficult to approach a perfect fit at the gingival working line in the slice cavity type as it is in the G. V. Black type cavity. But with the present-day technic in casting, it is not a difficult procedure to fit any type of well-prepared cavity. It is only a matter of doing each step of a good inlay technic with exactness to insure uniform end-results. In casting gold against a sharp corner in the investment, it is not likely that the investment will yield, provided it is of a good texture and possesses strength; nor are we likely to have rounded surfaces at these sharp angles if the mold is properly cured. The cause of these rounded angles in castings is the failure to remove all of the wax that has been dissipated into the investment approximating the mold proper, and when the molten gold strikes this point, gas is produced, and consequently a rounded angle will result. This is particularly true of castings that have a large core such as the full cast crown. Probably in no other department of dentistry has there been more research work done than in the art and science of casting gold inlays. There has been so much progress made in the past few years that, in comparison, it is delightful to see the beautiful castings that are made with the present-day technics for almost any type of cavity. These castings are made for cavities in porcelain teeth and steel dies, in both of which it was formerly very difficult to approach a desired fit. With a scientific working knowledge of the physical properties of wax and investing material and proper curing of the mold, it is not a difficult procedure to compensate for the shrinkage that occurs in gold when passing from the molten to the solid state. It is possible to gain some expansion from the plaster content of the investment by spatulation, expansion of the wax pattern in a slow setting investment and some expansion from the refractory materials of the investment when heat is applied. With the small amount gained from the investment and a larger amount gained from the wax, we are able to compensate for the shrinkage occurring in gold with the ordinary size casting for tooth restoration. With this knowledge at hand, it is not a question of making the casting for the various types of cavities, but is a question for the operator to decide as to the best type of a cavity for that particular restoration, whether it be a single inlay or a bridge abutment. If one has a good cavity preparation of any type and a good wax pattern properly cared for, it is not difficult to compensate for the variables that occur in the casting of the mesioclusodistal inlay and the three-quarter crown. Very fine inlays are made by the indirect method, which takes a longer time than does the direct method of inlay procedure; that is, in the hands of the ordinary operator. The wax impressions from the slice type cavities are somewhat more delicate to handle by the direct method than by the indirect method. In any type cavity that we choose, the first

consideration is conserving pulp vitality, and in using the slice preparation, we sacrifice the least amount of tooth structure. Whether or not it affords sufficient retention for all bridge abutments is a point open to conjecture among many skilful operators today. In bridgework, it is for the operator to decide what the stresses are in the particular case, and whether the bridge is mechanically right in consideration of the forces that will be applied to it. This necessitates a knowledge which usually comes from the pangs of failure in the past. I believe it should be left to the judgment of the operator to choose the type cavity that is best fitted for the conditions present.

A SIMPLE ACCURATE PROCEDURE FOR TREATING AND FILLING ROOT CANALS

By CARL J. GROVE, Ph.G., D.D.S., F.A.C.D., St. Paul, Minn.

MUCH has been said and written in an effort to discourage the treatment and the retention of pulpless teeth. These efforts have succeeded to the extent of greatly retarding progress in this branch of dentistry, a most regrettable state of affairs, for the existing situation is an admission that the profession believes that it is not equal to the problem. I do not wish to be understood to discredit the commendable work that has been accomplished by those who are striving to solve this problem, for I am sure that, in time, it will be satisfactorily solved, but the lack of support by the dental profession generally has tended to reflect discredit on the qualifications of the profession. Satisfactory advancement cannot be expected until dentists assume a more whole-hearted spirit of cooperation in solving this problem.

Since an abundance of evidence has been offered that pulpless teeth can be satisfactorily treated, I fear that the lack of united support may be due in a measure to indifference on the part of many dentists. The fact that root-end tissue of pulpless teeth continues to develop for a period of years after the pulp has been removed proves conclusively that such teeth are not infectious. Complete closure of the foramen by secondary cementum indicates that satisfactory repair follows pulp removal. When satisfactory healing of the periapical tissue occurs, it can safely be assumed that such apical areas are no more susceptible to infection than the membrane on other portions of the root, and the logical conclusion must be that such teeth are likely to remain free from periapical infection during the life of the tooth, provided the foramen has been properly filled with impermeable material.

The one thought that should be uppermost in the mind of the operator is to seal the foramen hermetically at the dentinocemental junction, in order to prevent bacteria escaping from the dentin into the periapical region. It cannot be expected that tissue will remain free from infection where bacteria are supplied with a most suitable place for propagation and are permitted to remain in its presence, as occurs where the filling fails to reach the cemental junction. It is impossible for any tissue to remain healthy under such conditions.

*Received for publication, March 7, 1930.
*Read before the Pennsylvania State Dental Society, May 16, 1929.

APICAL DENTINOCEMENTAL JUNCTION

It is obvious that in order to maintain a state of health of the periapical tissue after pulp removal, the apex must be hermetically sealed. The point to which the filling should extend is the dentinocemental junction. If the filling does not reach this junction, bacteria will escape through the open tubules of the dentin to the periapical tissue. As is well known, dentin is of tubular structure, with the opening of one end of the tubule entering the root canal. When bacteria are present in the tubules, these organisms migrate into the canal, and then into the periapical tissue through the foramen. These tubules extend to the dentinocemental junction; therefore, if the canal is not sealed at this point, bacteria will have an exit into the adjacent tissue.

It is necessary that we have a correct understanding of the anatomic relationship of this tissue. The general conception of the "apical dentinocemental junction" is that it refers to the point of contact of the primary dentin and the primary cementum at the apex of a tooth. That a definite junction of these two structures exists cannot be questioned, since the development of dentin precedes the development of the cementum. This line of demarcation is due to the difference in the histologic character of these tissues. If sections are not cut longitudinally with the apical portion of the canal, a correct representation of this condition may not be disclosed. A convexity or concavity on the surface of the root may also be misleading. This may occur in the study of sections that are selected at random, but when sections are prepared for the study of this condition, it will be found that a definite junction exists.

Fig. 1.—Cementum formed in foramen by obliterating pericemental membrane.

The condition to which I refer is not such as is found where the cementum has been deposited in the foramen of the teeth of middle life or advanced age, as is shown in Figure 1. It will be observed that a large number of canals extend through this structure into the periapical region, and there is also an intermingling

of dentin. One should not confuse these findings with the apical dentinocemental junction.

Filling to the dentinocemental junction would be of no avail unless impermeable materials were used. Many of the materials used today do not possess these physical qualities. When these properties are lacking in the filling material used, bacteria in the dentin will sooner or later find their way to the periapical tissue. When germicides are incorporated in the material, bacterial invasion may be delayed until this section is lost. After a time, this will occur, for there are no permanent germicides. Before I enter into a detailed discussion of the materials I use for filling root canals, I wish to take up the different phases of the technic.

Fig. 2.—Pericemental membrane in divergent foramen.

ANATOMY OF THE ROOT END

It would seem that Nature must have anticipated that removal of the pulp would sometime be necessary, because provisions were made for the success of such an operation by providing the root end of the canal with pericemental membrane in place of pulp tissue. The pericemental membrane possesses many char-

acteristics which are advantageous: (1) it has reparative power; (2) it is more resistant to irritation, and (3) it possesses the power of producing cementum. I have repeatedly called attention to the fact that if the tissue in the foramen is left intact in pulp extirpation cementum will form to close the foramen, provided an impermeable nonirritating material is used to seal the foramen completely.

Figure 2 is a longitudinal section of a tooth of youth, showing clearly that the membrane is in the foramen. Figure 3, another section, shows the tissue in the foramen. When this tissue is not removed with the pulp, it can reasonably be expected to be transferred into cementum closing the foramen as is seen in Figure 4.

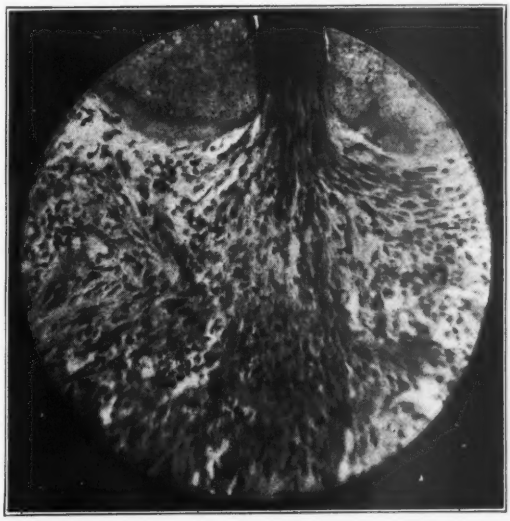

Fig. 3.—Divergent foramen with pericemental membrane in place.

The pulp should be removed at its junction with the membrane, which is at the dentinocemental junction. The tissue beyond that point should not be unduly injured either by instrumentation or the use of medicaments, for the highest point of resistance should be maintained to prevent any possibility of infection following pulp removal, also to avoid any interference with the process of healing or the function of the cementoblasts present in this tissue. It is these cells that produce the cementum closing the foramen. The cementoblasts are required to perform a most important service after pulp removal in the development of the root end as well as in closing the foramen. Removal of the pulp does not necessarily arrest development of this part of the root, for this process is carried on altogether by the cementoblasts in the membrane. These facts must be recognized before the importance of these tissues will be fully appreciated. If it were not for these tissues, I fear treatment of pulpless teeth would be futile.

It is essential that we have a technic making it possible to remove all the pulp tissue without causing injury to the tissue beyond that point. The technic must also make it possible to fill the canal to a desired point without traumatizing the tissue in the foramen. Where such a procedure is carried out, cementum will form to close the foramen, as has already been shown. The technic which I describe makes it possible to remove the pulp at any desired point and will also control the placing of the filling in such a manner that it will be impossible to go through the foramen. This is accomplished by the use of an instrument which measures the length of the root canal to be operated on, and the same instrument controls the placing of the root filling material. Before describing this technic, I wish to call attention to the origin of multicanals, as I believe this knowledge has an important bearing on successful root-canal surgery. This, of course, refers only to teeth with vital pulps.

Fig. 4.—Cross-section of apex, proving that cementum does form to close foramen; which frequently occurs with proper treatment.

ORIGIN OF MULTICANALS

Figure 2 shows the apical condition of the root at the time of eruption. The very large foramen is filled with peri-

cemental membrane. As time goes on, the foramen is diminished in diameter by the deposition of cementum, and as cementum is formed, the membrane is obliterated. A number of vessels pass through the membrane to the pulp chamber. Sometimes, the vessels pass through the membrane in a bundle, and, sometimes, the vessels pass into the pulp chamber from different positions, from all sides. As the membrane is obliterated to make space for the cementum formed, the vessels are left intact and cementum is developed around them. When the vessels pass into the canal in a bundle, only one opening is required, and this is formed by the cementum as it is laid down to diminish the diameter of the canal. Since the vessels are essential in order to supply blood to the pulp, they are not destroyed.

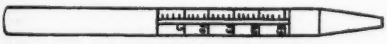

Fig. 5.—Measurement control instrument, used in standardized technic.

It will be observed that the canals are formed largely by cementum, as can be seen in Figure 1, although some dentin is present adjacent to the pulp, a condition which does not develop until middle life or advanced age. This should not be confused with the apical dentinocemental junction. The calcic material does not form for some years after the development of the junction. Because dentin is usually present and a number of canals exist in this structure, it is advisable to have the root filling extend deep enough into this deposit to reach a point where there will be no possibility of the bacteria having an exit through these openings. While this procedure may complicate the operation somewhat, such a step is justified as a preventive measure. While it is impossible always to determine when such a condition exists, it can be safely assumed that when the roentgenogram indicates that the measuring broach does not extend to the apex, this fact is due to the presence of this deposit.

To enlarge or extend this opening, I use hydrochloric acid. This may seem to some to be a hazardous procedure, but it will be found that hydrochloric acid is not very destructive to vital tissues unless it remains in contact with the tissue, especially when the acid is diluted. Sulphuric acid is very destructive, and there are also other decided reasons why sulphuric acid should not be used in root-canal operations. Sulphuric acid produces insoluble substances by its action on the tooth structure, which is objectional, in that these substances cannot be removed from the canal, a permeable material remaining which serves as a factor in the failure of root-canal operations. Hydrochloric acid produces soluble substances or a liquid that can be easily removed by the use of absorbent cotton. Another great advantage hydrochloric acid has over sulphuric acid lies in the fact that a given amount will dissolve about five times as much tooth structure, and will act more quickly.

Fig. 6.—Drawing of cuspid to illustrate shoulder in pulp chamber, used in measuring length of canal and filling canal, making it possible to fill to any desired apical point.

I have heard it stated that the action of acids on tooth structure is limited because of its ability to coagulate albumin; or that its action upon calcic materials ceases because a coagulum is formed. This is not correct. Cessation

of the action of acids on tooth structure is due to the neutralization of the acids by the calcium present. Albumin has no part in limiting the action of acids. It must be remembered that after complete decomposition of the pulp tissue, no albumin is present in the tooth structure. The presence of organic tooth substance does not necessarily mean that albumin is one of the constituents. It is generally believed by members of the profession that coagulated albumin will prevent the penetration of medicaments. This is not a fact.

I have coagulated albumin by the use of acids, and by various agents used in the treatment of septic root canals. I then tested the permeability of these coagulums, and it was found that, in every instance, the coagulated mass was permeable by the agents used in producing coagulation. To determine the permeability the liquids used for coagulation were colored. I then immerse the coagulum in the colored solutions. It was found that the entire mass was penetrated by the colored liquid, which proved that coagulated albumin was not impermeable, and, therefore, medicaments possessing these properties are not contraindicated in the treatment of septic root canals. While the coagulum may retard the penetration slightly, it cannot do so sufficiently to be of any serious consequence, especially the small amount of albumin existing in the tissue of a root canal. Frequently, albumin is not present in the root canal. Where complete decomposition of the pulp tissue has occurred, the elements composing this substance have been broken up and united with other elements present to form new products.

REFERENCE CHART

UPPER TEETH	Length of root	Reamer Required	LOWER TEETH	Length of root	Reamer Required
Central	12¼ M. M.	No. 28	Central	11¾ M. M.	No. 25
Lateral	12¾ M. M.	No. 27	Lateral	12½ M. M.	No. 25
Cuspid	17 M. M.	No. 27	Cuspid	15 M. M.	No. 25
First Bicuspid	12 M. M.	No. 26	First Bicuspid	7½ M. M.	No. 26
Second Bicuspid	13¾ M. M.	No. 27	Second Bicuspid	14 M. M.	No. 26
First Molar	12½ M. M.	No. 25	First Molar	13 M. M.	Mesial R. No. 26 Distal R. No. 25

Fig. 7.—Chart giving the average length of roots and size of reamers indicated for standardized technic.

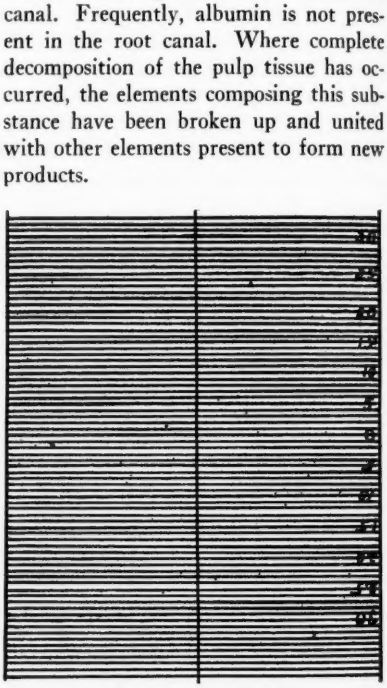

Fig. 8.—Millimeter graph for measuring root canals.

The chemical phase of this subject is not receiving the attention that it deserves. This knowledge has a practical application in the treatment of putrefied pulps. The remedies used should be of such nature that they will unite chemically with the products resulting from decomposition of the pulp. This is especially advantageous where the remedy unites chemically with the gases present, overcoming pressure and thus obviating

pain following the development of gases.

The two principal gases formed are ammonia and hydrogen sulphid, which not only cause pain when they escape through the foramen but also produce serious irritation to the periapical tissue, making them more susceptible to infection of the invading bacteria present in the canal.

Some years ago, Dr. Buckley gave a complete and comprehensive presentation of the chemistry involved in the decomposition of the pulp tissue. Such knowledge is of sufficient importance to merit an important place in the treatment of decomposed pulps, and the employment of germicides and antiseptics can be more efficiently applied when the value of this knowledge is recognized.

TREATMENT

Before there can be an intelligent discussion of the diseases encountered in the treatment of pulpless teeth, we must have an understanding as to what conditions exist. To simplify treatment and to make the presentation of this discussion more easily understood, I have worked out a classification of pulpless teeth. Class 1: Exposed noninfected pulps, recent exposures. Class 2: Infected pulps. Class 3: Acute periapical infections. Class 4: Partly filled canals, noninfected periapical tissue. Class 5: Chronic periapical infection.

Noninfected exposed pulps in Class 1 are those accidentally exposed. If asepsis is maintained, the pulp can be removed immediately, and the root canal operation can usually be completed at one sitting. When it seems advisable to divide the work into two sittings, only a mild antiseptic should be used as a dressing. A 10 per cent solution of cresol in glycerin makes a very satisfactory remedy for this purpose. It is miscible with water in all proportions because of the glycerin content, and it will therefore mix also with the serum, which is likely to exude from the periapical tissue into the canal. The advantage of a remedy possessing such properties is that the exudate becomes a part of the antiseptic solution, which prevents any possibility of the serum's becoming infected, at least for a short time. Another favorable feature of this remedy is that it is not irritating to the periapical tissue.

In Class 2 cases, the pulp chamber is opened with a round bur and the débris removed from the pulp chamber and the openings of the canals with a sterile barbed broach. Extreme care must be used to avoid forcing any infectious material through the foramen. A small pellet of cotton saturated in a solution of chloral hydrate and thymol is then placed in the pulp chamber, sealed and left for three or four days.

At the second sitting, we adjust the rubber dam, and swab the tooth with alcohol, iodin or mercurochrome. As much of the decomposed tissue in canals is removed as is possible without forcing any material through by the use of sterile instruments. Another dressing of chloral hydrate and thymol is sealed in and left for three or four days.

Strict asepsis must be maintained at all times. At the third sitting, we again adjust the rubber dam, and if the dressing is free from odor, we take a culture and, if it is found negative, proceed to fill the canal according to the method described under technic.

Before proceeding to describe the treatment of Class 3 cases, I wish to discuss the preparation called chlorothymol. This is made by taking equal parts of thymol and chloral hydrate and triturating the mixture in a warm mortar until it is liquefied. Sufficient acetone should

be added to keep in solution. Thymol is used for its germicidal power; acetone dissolves fats, making penetration of the thymol more effective. The chloral hydrate is used because it unites chemically with the gases of putrefaction, which permits sealing of the remedy in canals where decomposition occurs, and thus prevents pain after the sealing of the teeth. No hesitancy need be felt in sealing this remedy in teeth with decomposed pulps. I have used this mixture with entire success for more than fifteen years.

In Class 3, we treat with chlorothymol until the odor disappears, then take a culture and, if it is negative, fill the canal.

It is my belief that acute periapical infections usually can be successfully treated, but these cases should always be looked on as somewhat questionable.

In the treatment of Class 4 cases, we place a rubber on the teeth and proceed aseptically to remove the root filling, take a culture, seal in chlorothymol and dismiss the patient. If the culture is negative, we fill the canal at the next sitting; if positive, we treat it as in Class 2.

Class 5 cases are hopeless, and, in my opinion, these teeth should be extracted.

TECHNIC FOR OPENING AND STERILIZING CONSTRICTED ROOT CANALS BY THE USE OF ACIDS AND HEXYLRESORCINOL

When difficulty is encountered in opening root canals, it may be overcome by the use of hydrochloric acid. In combination with the acid, I use a hexylresorcinol, a very efficient germicide because of its power of penetration under favorable conditions, owing to surface tension. A high surface tension gives the solution greater penetration and so it is more destructive to bacteria, but this force is easily altered by the presence of certain soluble substances. In the presence of soluble organic substances, the force of penetration is lowered, but if a soluble inorganic substance is added, the surface tension is raised, a greater power of penetration resulting. When hexylresorcinol is placed in a putrid pulp chamber, the organic products present, formed by pulp decomposition, will lower the surface tension, thereby reducing the efficiency of the germicide, but if it is used in conjunction with hydrochloric acid, this change does not occur, because acid will destroy such organic products and will thus produce inorganic substances by its action on tooth substances, which will tend to raise the surface tension, making the penetrating power greater.

The advantage of using an agent having great penetrating qualities is obvious to everyone, as this reduces the time usually required for the treatment of septic root canals. As I have already stated, the products formed by the action of hydrochloric acid are soluble and are, of course, dissolved by the liquid of the acid. The bacteria existing in the dissolved dentin formed by the action of the acid are, of course, present in the solution. The hexylresorcinol will penetrate this solution almost immediately, destroying the organisms present, and, in such a favorable environment, it is safe to assume that the hexylresorcinol will even penetrate into the tubules of the dentin a considerable distance. It is my belief that the sterilizing effect following the application of acid-hexylresorcinol will be far greater than the results from germicidal agents that are sealed in the canal for a period of days. For some time, I have used this mixture in the treatment of all forms of septic root canals, previously to sealing in the medicament. Since this procedure is in a somewhat experimental stage, I hesitate

to recommend it as a part of the technic, although I have no reason to believe it has any objectionable features.

A solution of sodium bicarbonate should always be used to neutralize the acid.

STANDARDIZED TECHNIC FOR FILLING ROOT CANALS

For some years, I have carried on a series of experiments for the purpose of developing a technic and to decide on suitable materials to be used in conjunction with a simple procedure that could be readily acquired by the general practitioner.

The first requisite of a successful root canal technic is that it be possible to seal the canal at any desired point, and this should be accomplished without the consumption of a great deal of time.

In order to fill a root canal properly, it is necessary to know its length. This can be accomplished by measuring the length of the canal accurately by means of an instrument that I have devised for that purpose, the measuring control broach holder (Fig. 5). It is very similar to the ordinary broach holder except that it has a slot extending through the center of the handle with a vernier scale on each side of the opening. It also has a tapering end to allow it to enter the pulp chamber of the tooth where a shoulder is established as a rest or a landmark from which the measurement starts.

1. The first step in this technic is to establish the shoulder in the lower part of the pulp chamber by the use of an end cutting bur (Fig. 6). The holder cannot extend beyond that point.

2. We then refer to the chart for the approximate length of the tooth to be operated on (Fig. 7). This chart has been compiled from the measurement of the length of several thousand roots. While this is the average length, it is rather surprising to find how close to the average each tooth is. We now place a measuring broach in the holder at the point indicated on the chart, inserting the broach into the canal until the holder is stopped by the shoulder. Those who do not have a roentgen-ray machine will find this chart very helpful. Since it gives only the average length, it cannot be expected that the apex will always be reached unless a roentgenogram is taken, but better operations will be performed than by the methods now generally used.

Measurement and measurement control are among the chief factors in successful root-canal surgery, and the lack of this aid has always presented a serious problem to root-canal operators. If the operator will follow the technic I am about to outline, this uncertainty will be eliminated.

3. We will assume that the pulp is to be extirpated. A standardized barbed broach is placed at the reading record. All instruments are the same length; therefore, the same apical point will be reached by all root canal instruments. When the broach is inserted into the canal until the holder rests on the shoulder, a complete removal of the pulp will be assured.

4. The canal should now be reamed. The standardized reamers, which have a blade of only about 7 mm., are used. Such an instrument will make it possible to ream a canal in a much shorter time. If the apical 7 mm. is reamed and perfectly sealed, the results will be just as satisfactory as if the whole canal is reamed and filled. The size of reamer indicated for the tooth in question is recorded on the chart. The size is determined from the measurement of the

diameter of several thousand teeth, the diameter being only slightly larger than the average size of the canal. Properly selected reamers will obviate unnecessary reaming, and the exact diameter of the canal will be known when the reaming is completed. In the second step, a method for measuring the length of the root canal was outlined. When the length of the root is known, the diameter can be obtained from the reamer used in opening the canals. This makes it possible to standardize the root filling materials to the instruments. The method will insure a perfect fitting filling, and it also makes it possible to place the standardized cone at the desired apical point. In discussing filling of root canals, I shall describe the materials recommended and the procedure of controlling the filling material. The reamer should be placed in the holder at the same point on the scale as previous instruments, and reaming should be continued until the holder rests on the shoulder; which assures that the reamer has reached the proper apical point.

Since the reamers are larger than the canals, a complete removal of all fragments of pulp tissue will always be accomplished. When there has been a considerable constriction of the canal, it is sometimes necessary first to use a smaller reamer, but this should be followed by the use of a reamer of proper size before the canal is filled. The use of hydrochloric acid is also sometimes necessary.

5. We next use a file of the same number as the reamer. This is essential to assure a perfect fit of the standardized cone. The cones will not fit properly unless files are used. There are files corresponding to each size reamer which should be placed at the same point on the scale of the holder as previous instruments used.

6. We will now assume that the canal is ready for filling. A small quantity of a liquid called neurolite is placed in the pulp chamber with a small pipet. Neurolite is a condensite, a synthetic resin obtained by the action of two or more chemicals. This particular condensite is a product obtained by the chemical reaction between carbolic acid and formaldehyd. Chemically, the resulting condensite is a polymerized hydroxybenzyl methylene glycol anhydrid. This is the same substance known in the commercial world as bakelite, used for pipe stems and insulators, and porcelite, used for dentures. As used in canal work, since it is necessary to have it in liquid form, it is diluted with acetone to the proper consistency. My purpose in using this substance is to provide a sealer or cement for setting the metal standardized cone, not for a filling material. On the application of heat, neurolite becomes very hard and the heat of the tooth is sufficient to cause it to harden. The absolute impermeability of this substance is its main advantage, as it is necessary to fill the canal with impermeable materials before we can expect to prevent bacterial escape from the canal. Other physical advantages are its cohesiveness, hardness and nonirritating qualities.

7. The cones that I recommend for filling root canals are made of gold. These cones are standardized to the various reamers and files. There are only four sizes required. The standardized plugger is placed in the holder at the same point on the scale as the other instruments. The cone is placed in the pulp chamber with pliers. The plugger should be used for forcing the cone to place in order to assure that it is properly seated. When the holder rests on the

shoulder, the cone is in place. It is best to rotate the plugger a few times before removing the holder. This is done to prevent the cone from adhering to the plugger as the neurolite is very cohesive. Acetone is used for removing excess neurolite. The pulp chamber should be filled with a suitable cement. There will be no possibility of overfilling or underfilling if this technic is carried out, and a complete sealing of the canal will be accomplished, making it impossible for bacteria to escape from the dentin into the periapical tissue.

The point I wish to leave with you is that to assure uniform results, we must practice root-canal surgery with the same care and precision as are employed in other important branches of dentistry.

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DISCUSSION

Bruce L. Taylor, Washington, D. C.: This paper is very opportune, coming as it does at this time. We must do something for the pulpless tooth or the tooth with the exposed pulp. I should hate to think that the dental profession is going to reach a stage where, when they remove an old filling or excavate a cavity and find the pulp dead or exposed, they must extract that tooth. If we are going to do that, there is no use having a school that requires six years or five years to graduate a dental surgeon. For the past four or five years, we have been adding a year or two to the dental curriculum. Our profession is coming more and more to the point where we depend on the roentgen ray to show us whether a tooth is pulpless or not. There are many who believe that every pulpless tooth should be removed. There are others who believe that every tooth with an exposed pulp should be removed. If that is the case, there is no use bothering with dental histology or pathology or many of the other subjects on the curriculum. Let us confine our work entirely to restorative measures and not have to worry about the rest of it. If we all began to practice preventive dentistry today, it would be impossible for us to handle the patients and prevent the diseases that we have to contend with, but that seems to me to be our only salvation. We must not have exposed pulps. If we have to extract the pulpless tooth and the tooth with the pulp exposed, we are not going to get very far. I am not afraid of the pulpless tooth or the exposed pulp. If I were in general practice again, I would certainly treat a number of these cases and I would follow closely the classification recommended by Dr. Grove, and which has also been recommended by A. B. Crane, of Washington, D. C. We are reaching a point where we forget that Nature helps us in any way whatever. The nearer we can get back to Nature, the more we can assist Nature, the more Nature is going to do for us. Suppose we have a tooth that shows a rarefied area, or suppose we have five teeth that show rarefied areas. Did you ever stop to think of this? A man weighing 150 pounds has 12 gallons of water in his system. If he has five teeth that give off a drop of this poison which comes from the ends of these infected teeth, and it is diluted with 12 gallons of water, just how virulent is that poison to cause these terrible systemic effects that we have? We know that we do have them. I have had them myself. I experimented for one year with a lower molar. I had a sore knee, and I thought it was from playing golf. I took the spikes out of the heels of my shoes; I thought that I had twisted my knee in some manner. Still the knee was sore. One day I broke off a piece of the filling in the tooth. When I went to put in a temporary filling to get rid of the sharp edges, I found the pulp was dead. This was just when we were beginning to believe in the focal infection theory. I said, "Now is a chance to experiment." I was going to the college to deliver a lecture at that time. After the lecture was over, I came back to the office and cleaned the tooth out thoroughly. I used Buckley's treatment of cresol and formalin (solution of formaldehyd) and I sealed it in. Three days later, I changed the filling and sealed it in. I left it there. Inside of a week, the soreness left my knee, and it was all right. I left the medicament in for three months. Then my knee began to swell a little and get stiff. I took the filling out and it was infected. There was a bad odor. I treated it again and left the second filling in. I thought perhaps the weather had something to do with it, or my diet, or something

like that. In three months more, the knee began to get sore again. I repeated this procedure four times. Then I had a roentgenogram made of the tooth. I found that the ends of the roots were absorbed, and there was a bad infection present. I had the tooth removed, and I have never had any trouble with the knee since. That was just one tooth, yet it caused all that disturbance. The toxin must be very powerful. There are thousands of teeth that are lost for the simple reason that the diagnosis was wrong. I remember a case in which one woman had three teeth which looked all right, but they were pulpless teeth. She was not feeling well. The doctor sent her to me to see if there was anything else wrong. From a roentgenographic examination and a thorough examination of her mouth, there appeared to be no infection present. On questioning the patient, I found that she was tired and worn out. She slept well and ate well, but she was nervous. I called up her physician and suggested that he have an abdominal binder made for her (she was overweight). He had that done and in a week the woman left just as well as anybody. I have had other cases in which the right kind of shoes cured lassitude and nervousness, and improved the digestion. When we attempt to make a diagnosis of any of these conditions, we must look at it from every possible angle; find out whether the patient sleeps on two pillows or one pillow, etc. In another case, a boy, aged 12, had a soreness in the right condyle region of the jaw. He went to two or three physicians, and they came to the conclusion that it was a third molar that was causing the trouble. I examined him and found no infected teeth and nothing else was wrong in the mouth. I said finally, "Which side do you sleep on?" He said, "My right side." I then asked, "What do you do with your hands?" "I stick them up under my chin this way," he replied. I said, "For the next few days, keep your hands down at your sides. Sleep on your back or your left side, and don't put your hands under the pillow or under your chin." Inside of a week, the boy was well. It just goes to show you what we have to think of when we are trying to make a diagnosis. We must save teeth. That is what we are here for, and we must make an attempt to follow Dr. Grove's excellent technic. He is giving us something which will not be difficult. It will take some care, but it does not take a great deal of time, and it is much better to save a tooth and make it healthy, to check up on it once or twice a year, than it is to extract the tooth and probably mutilate two others in order to put in an appliance that will give the patient as good service as the natural tooth.

George A. Coleman, Philadelphia, Pa.: It is regrettable that Dr. Grove does not begin his paper by giving us his classification, so that we may realize early that he is treating only a very selected group of pulpless teeth, and is really not considering the great question of focal infection, as very few of the teeth that he treats are harboring infection. Let me present again to you his classification of "pulpless teeth": Class 1. Exposed noninfected pulps, recent exposures. Class 2. Infected pulps. Class 3. Acute periapical infections. Class 4. Partly filled canals, noninfected periapical tissue. Class 5. Chronic periapical infection. The fifth class he does not consider worthy of treatment, so these teeth are extracted. The third class he considers doubtful, so many of these can be eliminated as beyond treatment. Unquestionably, 85 per cent of pulpless teeth are contained within these two groups, which leaves a small percentage for treatment. This is probably the reason Dr. Grove has such great success in his treatment of pulpless teeth. Nevertheless, we must realize that the tissue about the apex of a pulpless tooth, no matter how well treated, is a changed tissue, and when the general resistance is lowered, the resistant forces of this tissue are lowered likewise, and it is there that infection is going to plant itself and start trouble, even though that tissue has been rendered sterile through the canal of the tooth. Complete sterility of apical tissue on completion of root canal therapy remains to be conclusively proved, and is a very problematic condition, especially at a certain time of life. I should like to ask Doctor Grove how much consideration he gives to the age of the patient in treating pulpless teeth, and also whether he has a complete classification of types for immunity and susceptibility. I am sure he has, so here again we must eliminate a few more pulpless teeth from consideration and we have reduced the number which can be treated so that there are few actually left for treatment. Resistance is easily lowered by physical fatigue, nerve fatigue and the onset of some infection. There are any number of external forces which have the power

of lowering resistance, and the only reason more people do not succumb to these forces is because different types react differently. Unfortunately, there is only one way of classifying types, which is by family history, and even this is not infallible. We may find a weak link in even the strongest family chain. There is a great opportunity for some investigators to make the work of the members of the healing art easier by developing some fast and hard rule whereby our patients can be definitely classified by types. Some day this may occur. We have discussed briefly the possibility of external forces attacking the system and lowering resistance. There is, of course, always the chance of being able to combat these forces, but let us consider the internal force, which is present, and although perfectly normal, is even more destructive than any of the external forces. As we develop from infancy to adult life, we are always apparently on the upgrade. Our energy is tireless and we are able to accomplish a great amount of work without much effort. But there comes a time when even the strongest find it necessary to call a halt. What causes this? Why cannot we go on as vigorously as we ever did? It is because senile decay has stepped in, and we find ourselves on the downgrade instead of on the upgrade. In other words, a perfectly normal, natural process is lowering our resistance, and it is from this period on in the lives of our patients that we must be on the alert to combat external forces, which will hasten the work of Nature. It is at this point that I would like to warn each of you not to place yourself in a position where you are aiding Nature in her destructive action, by leaving possible or probable infected pulpless teeth in the mouth. We should realize that an infected pulpless tooth may be the means of creating a vicious circle which will destroy the patient before his or her time, for we must remember that as senility sets in, every organ in the body becomes less energetic and less resistant to external forces. Grove begins his paper with the statement that "much has been said and written in an effort to discourage the treatment and the retention of pulpless teeth." I might answer this by saying that a great deal has been said and written in an effort to encourage the treatment and retention of pulpless teeth. It is the most controversial question of our profession, and when this problem is finally solved, as Dr. Grove hopes in time it will be, we will have reached the millennium. This will be a happy old world and there will probably be no need for dentistry. I believe that the profession does generally give this problem plenty of thought and consideration, but does probably fail generally in the attempt to solve it because it is impossible for them to do so, at least as far as our present-day knowledge is concerned. There is one consideration which must be weighed carefully in the saving of pulpless teeth, and that is what we might term "economy of time." To carry out conscientiously, skilfully and thoroughly root canal therapy requires an armamentarium, the manipulation of which will run into considerable time. Add to this the treatment involved, and we will find that it will take very few teeth to demand all of our working hours. We will have very few minutes left for preventive operations, which we know are all important. In fact, they will not only be neglected, they will also be ignored completely. I fully realize that this time proposition will bring forth a great deal of discussion, but weigh your own time carefully, and I believe you will hesitate before condemning it. Dr. Grove says, "I have repeatedly called attention to the fact that if the tissue of the foramen is left intact, in pulp extirpation, cementum will form to close the foramen, provided an impermeable nonirritating material is used to completely seal the foramen." I have always hoped that this might be true, but I have also always questioned that it could happen. Dr. Hopewell-Smith says, "We may hope for this, but must not expect it, as it occurs very seldom, if at all." Hermann Prinz says, "It may occur infrequently." Joseph L. Appleton feels that this is a rare possibility. There are many more reasons why we should think clearly and honestly before saving pulpless teeth, but time will not permit us to discuss the question further except to point out that quite a number of our most skilled root canal therapists have become discouraged because of the results obtained, and not because of the hard work involved in their chosen field.

INFLUENCE OF DIET ON BONES AND TEETH*

By W. McKIM MARRIOTT, B.S., M.D., St. Louis, Mo.

IT is generally recognized that the development and structure of bones and teeth may be influenced by diet during the growing period, but the fact does not seem to be appreciated that fully developed bones and teeth are live, active organs dependent for their structural maintenance on adequate nutrition. Bones and teeth have a metabolism comparable to that of other organs of the body. Nutrient material is brought to them by way of the blood and lymph, which serves to strengthen the structure and restore damaged or worn-out tissues.

Unless substances necessary for nutrition are continuously supplied, the natural wear and tear may not be repaired. Furthermore, alterations in the nutrient fluids brought about by inadequate diet may actually lead to disintegration with removal of the mineral matrix, chiefly calcium and phosphates. That the bones have a definite vascular and lymphatic system has been known for a long time. It has also been known that the vascular dental pulp is in connection with lymphatics penetrating for at least a short distance into the dentin. It has been demonstrated only within recent years that the entire dentin has a lymphatic circulation, and, further, that even the enamel is supplied with a similar circulation. That this is the case has been established chiefly through the brilliant investigations of C. F. Bödecker.[1]

It has been shown that lymph spaces surround the capillaries of the pulp and that these lymph spaces, in turn, bathe the odontoblastic layer of the dentin and communicate with lymph channels passing completely through the dentin to the enamel. These minute lymph channels, or dentinal tubules, are identical with the so-called "fibers" of Tomes. Through these channels, or odontoblastic tubes, the fluid elements derived from the blood pass to the dentino-enamel junction, and some pass across the junction into the enamel, where they connect with a series of channels which pass between the enamel rods to the surface of the tooth. These channels between the enamel rods are infinitesimally small and difficult to demonstrate microscopically except by special technic.

That such channels do exist and that they are permeable has been confirmed by the work of E. W. Fish,[2] who introduced methylene blue into the vital pulp of a dog's tooth and, twenty-four hours later, demonstrated passage of the methy-

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*The papers of Drs. Marriott, Wasson, Key and Marshall (published in the July issue) were presented as a symposium on "Bone."

1. Bödecker, C .F.: Dent. Cosmos, 71:586 (June) 1929.

2. Fish, E. W.: Circulation of Lymph in Dentin and Enamel, J. A. D. A., 14:804 (May) 1927.

lene blue through the dentin and enamel. Histologic sections showed the thin lines of blue, corresponding exactly to the tubules in the dentin and inter-lamellar spaces of the enamel. That the same type of lymph circulation occurs in the case of human teeth is evident from the observations of Percy R. Howe[3] on a patient who died of lead poisoning. The presence of lead was demonstrated in the lymphatics throughout the dentin and enamel. It is not known whether the lymph circulation through the dentin and enamel is entirely in one direction or whether there is a return flow from the surface. It is possible that the lymph penetrating the enamel escapes at the surface and is washed away by the saliva.

A tooth that is supplied by lymph of proper composition during the stage of growth may be expected to have a normal structure and to be resistant to the forces of disintegration and decay. If the lymph supply is interfered with or if the lymph is deficient in necessary elements, normal development of the tooth cannot occur and the fully developed tooth will be susceptible to disintegration.

Throughout the body there exists an interesting condition of equilibrium between the tissues and the fluids in which they are bathed. When the fluids are deficient in certain elements, these elements tend to pass out of the tissues into the fluids until an equilibrium is approached. This is true of bones and teeth as of other organs of the body. It has been demonstrated repeatedly in the case of patients receiving a diet insufficient in calcium salts or, for some reason, losing an excess of calcium salts from the body, that the structure of even fully developed bones changes, becoming more porous and finer, and containing less fixed lime salts. These changes may be readily demonstrated by the roentgen ray. That other changes also occur in the structure has been demonstrated by less direct methods. We thus see the importance of the circulation of a lymph of proper composition.

The lymph represents a portion of the fluid elements of the blood with dissolved salts and organic material. It leaves the blood by way of the endothelial lined capillaries. The composition of the lymph is therefore regulated by the composition of the blood plasma, and this, in turn, depends ultimately on the diet and the digestive and absorptive function. There are a number of factors which influence the composition of the blood plasma, but it is obvious that the plasma cannot contain substances which are not supplied by the diet. Hence, we see that, in the ultimate analysis, the maintenance of normal structure and function of the teeth and bones is not possible unless the diet is fully adequate.

When the diet contains all of the essential factors in sufficient amounts and there is no disease present, the composition of the plasma is constant to a remarkable degree. A reasonable excess of any particular substance in the diet does not increase the concentration of that substance in the plasma, as the excess either is not absorbed or is promptly eliminated from the body. A great excess of certain elements may change temporarily the character of the plasma. If, on the other hand, any one element is lacking in the diet, this element will also be deficient in the plasma or else will be removed from the body structures to make up for the deficit.

It is through the plasma and the lymph that materials for the structure and maintenance of body tissues are transported,

3. Howe, P. R.: Diet as a Fundamental in Dental Conditions, J. A. M. A., 79:1565 (Nov. 4) 1922; J. A. D. A., 15:1673 (Sept.) 1929.

but even though these materials are brought in adequate amounts, they are not necessarily utilized. The dumping of a load of bricks in front of a building is no assurance that construction will proceed. The factors which lead to the utilization of materials brought to body structures are not entirely understood. We do know that building up of new tissues does not occur in a normal manner in the presence of certain toxemias resulting from infection, nor does it occur when certain secretions of the endocrine glands or certain vitamins are deficient. We know, also, that there are embryologic and hereditary conditions which influence structure. A detailed discussion of these factors would be beyond the scope of this paper, which deals primarily with the influence of the diet.

The effects of diet on the development of the teeth of the individual are manifest even before birth, as the development of the teeth starts in intra-uterine life with beginning calcification of the deciduous teeth as early as the fourth fetal month. Materials for the development of the embryo are transported by way of the mother's blood and placental circulation, so that the composition of the blood plasma reaching the fetus is, to a large extent, determined by the diet of the mother. It is not entirely determined by this factor. Embryonic tissue possesses an extraordinary growth impulse which enables it to remove nutrient material even from fluids in which the amounts present are minimal. As a result of this growth impulse, the bones and teeth of the developing fetus remove large amounts of calcium phosphate and other materials from the blood and this depletion results in a disturbance of the equilibrium between the blood and tissues of the mother, so that there occurs an actual passage of such substances as lime and phosphates from the maternal tissues into the blood. In this way, the developing fetus grows at the expense of the mother. Deficiencies in the diet are therefore more likely to affect the mother than the developing fetus, but when the deficiency is too great, both fetus and mother are affected.

Observations on pregnant women have shown a definite decrease in the calcium content of the plasma. The mother can and does supply a great deal for the nutrition of the infant, even when her diet is insufficient. Lime and phosphate come from her own teeth and bones and protein from her own muscles, but she cannot supply that which she herself lacks.

The human body has not the power of storing any considerable amount of most of the vitamins, so that when the mother's diet is deficient in vitamins, the developing fetus will suffer from a deficiency of the same vitamins. As we shall see later, the vitamins which are especially concerned with the development of teeth and bones are the antirachitic, or D, vitamin, the antiscorbutic, or C, vitamin and the growth factor, or A, vitamin. These factors should therefore be supplied liberally in the mother's diet, as they are the ones which make it possible for the growing bones and teeth to utilize food materials brought to them. The diet of the mother should also contain adequate calcium salts.

When the diet of the mother is deficient in calcium and in vitamins A and D, the alterations in the mineral composition of the teeth of the young are much greater than when the diet is deficient only in calcium. The changes in the deciduous teeth of the young may consist,

according to Mellanby[4] and Toverud,[5] of incomplete calcification of the enamel and dentin.

Marshall[6] showed that when vitamin A alone is deficient in the diet of the mother, other factors being present in adequate amounts, the permanent teeth are affected, which makes them more susceptible to caries in adult life. Deficiencies of vitamin D alone in the diet of the expectant mother result in hypoplasia of the rachitic type in the deciduous teeth of the infant.

When vitamin C is deficient in the mother's diet, the teeth of the infant might be expected to show changes in the dental pulp and odontoblastic layer which interfere with normal development. These changes are discussed subsequently in relation to the effects of vitamin deficiency on fully formed teeth.

Any deficiency in the mother's diet during pregnancy influences chiefly the deciduous teeth, as calcification of the permanent teeth, with the exception of the first molars, does not begin until shortly after birth. Ordinary mixed diets of adults usually contain just about enough calcium to meet the needs of the body, but in the case of individuals taking very little milk and eggs, the calcium needs may not be completely met. During pregnancy, women often show a fastidious appetite and fail to take foods containing sufficient lime for their own needs, let alone the requirements of the developing infant. It is necessary, therefore, that the diet be carefully selected to contain foods affording calcium. The richest sources of calcium in the diet are milk, cheese and egg yolk. Cereals and vegetables contain calcium salts, but not in sufficient amounts to meet the calcium needs of the individual unless enormous amounts are taken. Milled cereals, such as white flour, contain even less calcium than the whole grains, and meat is almost entirely deficient in this element. The expectant mother should, therefore, be encouraged to take a considerable amount of milk daily. To many adults, ordinary liquid milk is distasteful. In such instances, the milk may be cooked in foods, added to beverages, such as cocoa, or taken as ice cream. It makes little difference what form of milk is used. Dried milk or evaporated milk are as good sources of calcium as is fresh milk. Evaporated milk is of especial value as it lends itself to the preparation of many dishes and by its use a relatively large intake of milk may be assured. Most of the calcium of milk is contained in the curd, so that cheese is rich in this element. Any form of chees may therefore be used as a substitute for milk to supply calcium.

The amount of milk that the expectant mother should take daily should be not less than one pint and preferably one quart, or its equivalent in the form of milk products. When lesser amounts than this are taken, the calcium requirement should be made up by the administration of lime salts, such as calcium lactate, acetate or gluconate. There is no indication for giving calcium phosphate, as this is less readily absorbed than other calcium salts, and the ordinary diet contains sufficient phosphate to meet the needs of the body. An excess of phosphate tends to cause calcium loss instead of fixation in the tissues.

Vitamins A and D, like calcium, occur more abundantly in milk and egg yolk

4. Mellanby, May, and Pattison, C. L.: Brit. Dent. J., 47:1045 (Oct. 1) 1926. Mellanby, May: 48:1481 (Dec. 15) 1927.

5. Toverud, Guttorm: Suppl. Den Norske Tandlarglfor. Tid., 8, 1926.

6. Marshall, J. A.: Dental Caries and Pulp Sequelae Resulting from Experimental Diets, J. A. D. A., 14:3 (Jan.) 1927.

than in other common foods. These vitamins are contained in the fatty portions of milk and are therefore not present in skimmed milk, but are present in butter and in full cream cheese. Cereals ordinarily contain no vitamin D. Irradiated cereals contain some of this factor. The amount of antirachitic vitamin, or vitamin D, in foods is variable. In order to insure an adequate intake of this vitamin, it would seem advisable to give extra amounts other than those contained in the food. For years, cod-liver oil has served as the chief means of administering extra amounts of vitamin D. If expectant mothers are willing to take cod-liver oil, one tablespoonful twice a day serves the purpose of supplying a sufficiency of both vitamins, but adults rarely relish this product, even when it is disguised with flavoring. Cod-liver oil concentrates consisting of the nonsaponifiable residue and containing the vitamins are now on the market. Some of these preparations are reliable sources of the vitamins (oscodol, etc.). They may be taken in tablet form without upsetting the digestion. Vitamin D alone may also be supplied in the form of irradiated ergosterol (viosterol-100 D). One or two drops of this practically tasteless preparation are equivalent in vitamin D content to one teaspoonful of cod-liver oil. Vitamin D is produced in the body as a result of exposure to sunlight. The sunlight coming through glass is ineffective, and it is essential that the sun should strike the bare skin.

Vitamin A occurs along with vitamin D in the fat of milk, in egg yolk and in cod-liver oil. It is also present in fairly high concentration in carrots and in some green vegetables, especially spinach.

Vitamin C, the antiscorbutic factor, occurs in especially high concentration in oranges and tomatoes. Smaller amounts are present in other fruits and in fresh green vegetables. Relatively little is present in milk. Vitamin C is partly destroyed by heating. It is fairly stable in the presence of acid, so that cooked fruits and tomatoes still contain considerable of this vitamin.

After birth, it is essential, in order that the further proper development of the deciduous and permanent teeth may take place, that the infant's diet be adequate in every particular. Mother's milk supplies all the essentials provided the mother herself is in good health and is taking a suitable diet, and provided the infant receives a sufficient amount of the milk. If the mother is not in good condition or if her diet is a poor one, or if the milk is scanty in amount, the infant may have to be fed artificially.

It is possible to prepare feedings for the infant, with cow's milk as a basis, which provide all the necessary elements in the nutrition, and the development of teeth and bones of such infants may be, in every particular, as good as that of the exclusively breast-fed infant. This assumes, of course, that the prepared feedings really are adequate. Only too often, the diets of artificially fed infants are grossly inadequate. It is not proposed to discuss infant feeding in detail. Suffice it to say that the artificially fed infant, receiving as much as 1.5 ounces of cow's milk per pound of expected body weight, and given, in addition, cod-liver oil and orange juice, receives a sufficiency of all those elements which are essential for the formation and maintenance of bones and teeth. Infants who are given mixtures containing a large proportion of carbohydrate, such as sweetened condensed milk, or malted milk, usually take too little milk with its contained calcium, vitamins and protein, and suffer from malnutrition and bone and dental

defects. With the present knowledge of the nutritional needs of infants, such improper types of feeding are inexcusable. This phase of the subject is discussed in greater detail elsewhere.[7] Simple underfeeding, or the giving of a diet too low in caloric value, but containing adequate amounts of mineral matter and vitamins, leads to general undernutrition and slow growth of the body as a whole. The bones continue to grow in length somewhat out of proportion to the body weight, but the skeletal development, as a whole, remains below normal. The muscles are lax and hypotonic so that the stimulus of muscle contraction on the growth of bone is diminished. This effect is observed in the maxillae. The undernourished infant has a narrow palatal arch and a narrow, pointed mandible, which gives him a peculiar mouse-like appearance. In such underdeveloped jaws, the teeth are likely to be badly crowded.

When certain particular elements of the infant's diet are lacking or are present in insufficient amounts, nutritional diseases of specific types result, some of which have a marked effect on bones and teeth. One of these is rickets, the chief cause of which is a deficiency in vitamin D. When this vitamin is deficient in the diet, calcium phosphate is not laid down in a normal manner in the developing bones and teeth. When calcium is deficient in the diet, a condition very similar, if not identical, is produced, and this is also true of deficiencies in phosphate. Certain interesting relationships exist between the requirements of calcium, phosphate and vitamin D. When calcium and phosphate are present in large amounts, less vitamin D is required for the prevention of rickets. When there is a large supply of vitamin D, the effects of calcium and phosphate deficiencies are less marked. Furthermore, an excess of phosphate in the diet in proportion to calcium leads to a loss of this latter element from the body and, likewise, a great excess of calcium leads to a loss of phosphate. An excess, therefore, of either calcium or phosphate may actually produce rickets. It is essential that a balance be maintained.

An infant receiving the amounts of milk indicated above, or a growing child receiving as much as 1½ pints of milk daily, obtains sufficient calcium and phosphate for his needs, the phosphate being, in proportion to the calcium, somewhat higher than the optimum. There is no need for the addition of extra calcium to the diet, and extra phosphate would, if anything, be harmful. The amounts of cow's milk usually taken contain no more than the bare minimum of vitamin D necessary to prevent rickets. Rapidly growing infants and children require larger amounts of this vitamin than do adults. There is also a greater need during winter than in the summer months, owing to the lesser exposure to sunlight during the winter. It is for this reason that it is advisable to supplement the diet of infants and children with cod-liver oil or viosterol, preferably cod-liver oil because this, in addition, supplies the A vitamin.

When, as the result of a deficiency of vitamin D or of calcium or phosphate or a lack of balance of the latter elements, rickets occurs, the bones are soft, poorly calcified and likely to be deformed by muscular contraction. Development of the teeth is retarded so that eruption of the temporary teeth is delayed. The structure of the teeth is less dense than normally, and they are softer, there being less calcium phosphate present in propor-

7. Marriott, McKim: Textbook on Infant Nutrition, St. Louis: C. V. Mosby Co., 1930.

tion to the organic matrix. Grieves[8] states that attaching-tissue defects occur which may consist of a loss of alveolar crests or an irregular vertical invasion of the alveolar walls and localized root exposure. Cervical deposits of calculi may occur. The effect of rickets on the jaws is perhaps even more important than that on the teeth, at least from the orthodontic standpoint.

A deficiency of vitamin A in the diet of the infant and growing child results in a retardation of the growth of the jaws as a whole. According to Marshall,[6] the most striking manifestation in the teeth is a change in the character of the odontoblasts, which lay down bone instead of dentin. This results in a less dense and less resistant calcification of the tooth structure. The pulp cavity becomes degenerated and often inflamed. The teeth of the child who has been fed for long periods on diets relatively deficient in vitamin A are especially susceptible to decay. Vitamin A deficiencies result in changes in the mucous membranes of the entire body, consisting of a keratinization of the surface cells. There results diminished secretion from the mucous membranes and the mucosa becomes less resistant to infection. There is a decrease of the flow of saliva and a tendency to the formation of salivary calculi and to mouth infections, all of which produce abnormal conditions at the surface of the teeth.

Marked deficiencies of vitamin C (the antiscorbutic factor), in the diet, result in scurvy. Slighter deficiencies, though not resulting in the active clinical manifestations of scurvy, nevertheless lead to pathologic processes in bones and teeth. Hemorrhages occur in the bone marrow and underneath the periosteum. The whole bone becomes somewhat porous and bleeds easily. Osteoblastic activity diminishes or ceases. Changes are especially marked in the epiphyses, which become easily separated from the shafts. In the dental pulp, similar changes occur. Some blood cells leave the capillaries, the odontoblastic layer ceases to function, newly formed dentin is absorbed and pulp calculi may occur. These changes all disappear promptly after the administration of a sufficient amount of the antiscorbutic vitamin, but if the vitamin has been deficient in the diet over a long period, completely normal conditions may not be restored. In vitamin C deficiencies, changes also occur in the gums, which become spongy, hemorrhagic and subject to infection. Active scurvy is not common at the present day, but the milder symptoms of deficiencies of the antiscorbutic vitamin are of fairly frequent occurrence. The extensive investigations of Howe[3] have served especially to emphasize the importance of an adequate supply of vitamin C in the diet.

Vitamin B is essential in the normal diet. According to recent investigators, what has been called vitamin B is in reality a mixture of two vitamins, both of which are essential to life and normal development. Fortunately, both are present in adequate amounts in practically all common foods and a deficiency of these factors is extremely rare. The effects of such deficiencies in bones and teeth have not been thoroughly investigated.

Protein is a necessary constituent of the diet, growing individuals requiring proportionately larger amounts than adults. The chief results of a deficiency of protein are anemia and nutritional edema. The latter condition appears to be the result of a decreased concentration of protein in the blood plasma.

8. Grieves, C. J.: J. A. M. A., 79:1567 (Nov. 4) 1922.

When protein is deficient in the diet of the growing infant, development is slow and the teeth erupt late; but as far as is known, there are no essential changes in structure. It has also not been determined just what effect a protein-deficient diet has on the teeth in the case of the adult. An excess of protein in the diet results in an excessive intake of phosphorus compounds which are, in the body, oxidized to phosphates, tending to some extent to rob the body of calcium.

Fats are not absolutely essential in the diet, but the associated fat-soluble vitamins are. Too great an excess of fat results in diminished absorption of the fat-soluble vitamins, a portion of these remaining in the unabsorbed fat and being lost by way of the bowel. In this connection, it is of interest to note that the taking of mineral oil seems to result in a similar loss of vitamins by way of the intestinal tract.

Carbohydrates, consisting of starches and sugars, are essential for normal nutrition and are the chief sources of energy of the body. Carbohydrates are harmful only when they comprise such a large proportion of the diet that inadequate amounts of minerals, vitamins and protein are taken. Children who eat large amounts of starches and sugar, or infants fed on proprietary foods having a high sugar content, often develop rickets, with the accompanying changes in the teeth, and these teeth decay easily. This is not so much the result of an excessive intake of carbohydrate, but of a lack of other food elements. Some evidence has been brought forward by Mellanby that cereals contain a substance which is actually inimical to the development of the teeth. The effects of this harmful substance, or "toxamin," as it has been called, are fortunately neutralized by the administration of sufficient vitamin D. Irradiated cereals should, according to this view, be without harmful influence on the teeth. The harmful effect of cereals may also be neutralized if they are eaten with cream, with its vitamin D .

We have considered the effects of diet on the development and structure of bones and teeth from the metabolic standpoint. A word should be said as to the local and mechanical effects of diet on the teeth.

It has been a matter of observation that primitive people who eat rough food are likely to have good teeth, but that their teeth deteriorate when they take the finer food of civilization. Some have attributed this to the cleansing effect of rough food. This point of view has been especially stressed by Sim Wallace. The chewing of hard and rough foods leads to an increase in the flow of saliva, which, being alkaline, tends to neutralize any acids which may be produced in the mouth as the result of fermentation. Rough foods also clean and polish the teeth. A more important effect of intake of rough food is that, when it is chewed, the muscles of mastication are brought into greater use, and there is also probably a better circulation to the teeth. Bone growth depends largely on muscular action. When this is weak, bone atrophy occurs. It is only with activity of the muscles of mastication that the jaws can reach their full growth and development. When muscular activity is diminished, the jaws are small, the palate is high and arched and the teeth are likely to be crowded. Malocclusion is of common occurrence. The daily diet should contain a certain amount of food which requires distinct masticatory effort. For this reason, hard breads and toast are preferable to soft breads, and rough vegetables containing fiber are desirable. Even tough meat and chewing gum may have their place.

Aside from the development of the jaws and the nutrition of the teeth, the character of the diet is generally believed to have a direct local influence on tooth surfaces. The use of soft, starchy foods and sugars is believed to favor the development of dental caries. These foods stick to the teeth more readily than other types of food and may be decomposed by mouth organisms, especially *B. acidophilus,* with the production of lactic and other acids. Long continued action of acid undoubtedly has a deleterious effect on tissue and particularly on a calcified one. It should be remembered, that, in the case of teeth, we are dealing with live tissues and not simple inorganic deposits of calcium phosphate. Live tissues are capable of resisting the effect of agents which destroy dead ones. For example, the stomach does not digest itself, although the gastric juice is entirely capable of digesting tripe.

It is problematic just how great a concentration of acid may occur as the result of carbohydrate fermentation in the mouth, and unless entirely protected from the action of the neutralizing saliva, such acid as is produced would not be capable of acting for any length of time. Fruits and vegetables of relatively high acidity may certainly be taken with impunity. Furthermore, various observers have been unable to produce dental caries experimentally by plastering the teeth with sticky sugar solutions, and caries, on the other hand, is observed in individuals who have kept the teeth scrupulously clean. Bödecker[1] has advanced the fascinating theory that the flow of the alkaline dental lymph neutralizes such acids as are produced. He also feels that the presence of proteolytic organisms capable of destroying the intercellular matrix is an important factor in dental decay. The observations of Boyd[9] and Drain regarding the arrest of dental caries following the administration of suitable diets to children in whom the teeth were cleaned no more thoroughly than previous to the institution of the diet would appear to indicate that the dietary conditions which influence the metabolism of the teeth are far more important than those which have merely a surface effect.

Our own experience is entirely in accord with this point of view. In the case of children whose diets have been deficient in milk, eggs and fresh vegetables, extensive dental caries has almost invariably been present. When the same children have been given suitable diets, extension of the caries has been checked, even in those cases in which there was a most flagrant disregard of the principles of mouth hygiene. Decay in a damaged tooth may be promoted by the presence of food containing proteolytic or fermentative organisms, but if an individual is taking a diet sufficient to provide for normal nutrition of the tooth, damage is not nearly so likely to occur.

Certainly, no one would discourage the practice of thorough cleaning of the teeth, for such cleaning undoubtedly is an important factor in preventing gingival inflammation and is certainly of value in preventing caries in the case of individuals who, as the result of a deficient diet, have teeth of poor structure and low resistance. The oft-repeated slogan, "A clean tooth never decays," has been somewhat overworked and does not tell the whole story. In the light of present knowledge, it might be more nearly correct to state, "A well-fed tooth never decays." Certainly, the clean, well-fed tooth has an excellent chance of survival.

A diet adequate for normal mainte-

9. Boyd, J. D., and Drain, C. L.: J. A. M. A., 90:1867 (June 9) 1928.

nance and development of the teeth may be simply arranged by any one. The services of a dietitian are not required, nor is there any need for the use of the proprietary preparations of the food faddist. All the necessary foods can be bought at the corner grocery except the cod-liver oil or viosterol, which may be indicated under special conditions when the individual cannot or will not take a sufficient amount of ordinary foods. The principles of an adequate diet from the standpoint of dental nutrition may be briefly summarized:

Milk, the most important constituent: not less than 1½ pints a day for a child; 1 pint for an adult, and 1½ pints for the expectant mother. The milk may be in any form.

One to two ounces of butter a day for an adult or child. Oleomargarin may not be substituted for butter as it does not have anything like the same vitamin content.

Two eggs daily for adults and one for young children; from one-half to one egg yolk daily for infants after the fifth month of life.

Two green vegetables every day, one of which should preferably be raw, as, for example, lettuce, cabbage or endive as a salad.

One fruit daily, preferably orange.

Some rough or hard food: toast, zwiebach, rough breads or cereal.

In the case of infants, an amount of milk equivalent to one-tenth of the body weight a day should be taken, and, in addition, from one to two tablespoonfuls of orange juice daily and from one-half to one and one-half teaspoonfuls of cod-liver oil two or three times a day; egg yolk, green vegetables and cereals after the sixth month.

In the case of the expectant mother and the rapidly growing child with dental defects, the diet should be supplemented by cod-liver oil or viosterol. The addition of calcium preparations is not indicated except when the amounts of milk taken in any form fall below those given above.

When these essentials in the diet are covered, it makes little difference what goes to make up the remainder of the diet. The individual may eat white bread or whole wheat bread, refined or whole grain cereals. The food may be raw or cooked. It may contain a great deal of vegetable food or a great deal of meat. It should be sufficient in total calories to allow for a normal gain in weight in the case of the growing child, and neither so excessive as to lead to obesity on the part of the adult, or so low as to result in poor nutrition.

Simple as are the principles underlying the construction of a suitable diet, they are not any too well understood by the average layman, or even by physicians. Only too many physicians consider the teeth not as essential structural units of the body, but merely as appendages which are sometimes the source of focal infection and must accordingly be removed. If the patient receives any advice as to preventive dentistry, it will probably come from his dentist. About the most important advice he can obtain is that concerning his diet.

THE PHYSIOLOGIC GROWTH OF BONE*

By W. W. WASSON, M.D., Denver, Colo.

THE osteoblast is given the credit for the origin and growth of bone. The origin of the osteoblast is not definitely known. One investigator, Sir Arthur Keith,[1] suggests that the osteoblast may come from proliferation of capillary buds, while a group headed by Leriche and Policard[2] insists that it has its beginning as a connective tissue cell. The reason that the connective tissue cell changes to an osteoblast is unknown. It is further stated that the osteoblast may change its function of forming bone and become an osteoclast for destroying bone. How and by what stimulus the calcium phosphate is produced by the osteoblast in a certain area to form bone is unknown. Watt[3] favors the theory that the process is a secretory act of the osteoblast rather than a chemical precipitation. Upon such knowledge of the origin of the bone cells and their chemical activities, the physiologic growth of bone is based.

Leriche and Policard, after many years of study, have tried to bring some order out of this chaos. They think there is some humor, some enzyme, which causes a preliminary edema of the tissue. The connective-tissue cell assumes an embryonic character as a fibroblast and then becomes a definite osteoblast. The circulation of the blood in the area of edema is less active, and the formation of bone by the deposition of calcium phosphate takes place. There are many general factors influencing this preliminary edema and the chemical activities of the osteoblast. Some of these factors are known and understood.

Rachitis, in which there is a faulty growth of the diaphyses of the long bones, characterized by rarefaction, is known to be due to a disturbed calcium metabolism. There is a disproportion between the calcium and the phosphorus content of the blood. The addition of vitamin D to the diet corrects the metabolism. Calcium phosphate is the substance which determines calcification. (Shear and Kramer.[4])

Cartilage, when removed from the body and placed in the proper solution of calcium and phosphorus, will form bone; that is, the correct solutions of calcium and phosphorus bathing the tissues *in vitro* are necessary for the formation of bone. Either a dead or an alive bone transplant is sufficient to give the necessary stimulus for the growth of bone. Bladder stones when left in an abdomi-

*From The Child Research Council, University of Colorado, School of Medicine.

*Read before the Section on Orthodontia at the Midwinter Clinic of the Chicago Dental Society, Jan. 15, 1930.

1. Keith, Arthur: Proc. Roy. Soc. Med., 21:301.

2. Leriche and Policard: Normal and Pathologic Physiology of Bone, St. Louis: C. V. Mosby Co., 1926.

3. Watt, J. C.: Arch. Surg., 15:89 (July) 1928.

4. Shear, M. J., and Kramer, Benjamin: J. Biol. Chem., 79:125-145 (Sept.) 1928.

nal wound have been known to stimulate the formation of true bone.[1]

Mechanical stress, as seen in the growth of bone and as practiced by the dentist and orthopedic surgeon, is one of the best stimulants for the production of bone. On the other hand, Macewen[5] states that bone will absorb under pressure more readily than will cartilage. By the proper mechanics, almost any change can be brought about in the shape or density of a bone, provided the local conditions for growth are suitable and the local stimuli are present.

Some writers doubt the influence of the endocrine system in the physiologic growth of bone. No one who has watched a case of acromegaly can doubt the influence of the internal secretions on bone growth. The same is true of the growth due to the sex glands. Inheritance may likewise be questioned; but how are we to explain the development of certain osseous centers at varying ages?

Bone must be considered as a connective tissue, reacting as other connective tissue does. A cancer of the prostate that produces fibrosis, an increase in the connective tissue, will, when metastasized to the bone, produce increased bone density. The toxins of bacteria, if in small amounts, will cause bone proliferation. Trauma or fracture will bring about bone production and repair.

The heterotopic formation of bone is not understood. Such deposits are found in the mammae, tonsils, eyes, muscles, etc. Macewen thinks they are due to wandering osteoblasts, and that one function of the periosteum is to restrain these osteoblasts.

Thus, the whole problem of the physiologic growth of bone is a very complex one. There is probably never an occasion when there is only one factor to be considered. Rather, we must be familiar with the entire situation in order to expect the best results in an operative case or in the treatment of disease. What of the future? What can be accomplished in the study of the morphogenesis of bone as well as its cytologic or its physiochemical properties?

In this connection, I would call attention to the part the roentgen-ray has played in increasing our knowledge of bone growth. True physiologic processes leave behind no record of periods of activities to be read at necropsy.[6] The roentgenogram has given us a method to record and study living physiologic processes, their periods of increased activity or recession. When taken at definite intervals, these films portray a sequence of events which is much more instructive than any number of experiments or necropsies. Such roentgenograms of the osseous system not only would portray the growth curves of the various bones, but would also enable one to associate the curves with the growth curves of weight, the glands of internal secretion, the environment and the seasons of the year. Further, the roentgen ray has not been utilized to its fullest extent. The roentgenogram made by passing the rays through a pinhole[7] enables one readily to have a magnification of the bone to the tenth or fifteenth power. Such roentgenograms, particularly when taken in sequence, would materially increase our knowledge of the physiologic growth of bone.

I should also like to suggest the motion picture as another method of studying this kind of physiology. We have taken

5. Macewen, William: Growth of Bone, p. 32.

6. Wasson, W. W.: Thymus Gland, Arch. Otolaryng., 4:495-510 (Dec.) 1926.

7. Wasson, W. W.: X-Ray as a Microscope, J. Radiol., 3:268 (July) 1922.

roentgenograms of the heads of children, and particularly of the nasal accessory sinuses, from birth to 8 years of age. These roentgenograms were made every three months for each child, and each one portrays a separate and definite step in the growth of the nasal accessory sinuses and the facial bones. It has then been possible to build these roentgenograms into a motion picture film, in order that the eye might visualize this action. It then becomes possible to see the nasal accessory sinuses grow and to study their relationship with the growth of the bones of the face. Infection of the sinuses may be observed and studied from its incipiency. The progress or recession of this infection can be noted and its influence on the physiologic growth of the sinuses and bone can be observed.

Growth curves of either the sinuses or bones may be plotted with accuracy and correlated with the other factors influencing growth. It is found from such curves that growth of bone is not a steady and continuous process. For example, the bones of the face grow rather rapidly until the fifth year, at which time there is a period of practically no growth until the child is about 6½ years of age. Such observations can be made only by intelligent and detailed examinations of the same child, in chronologic sequence.

CONCLUSIONS

1. The local stimuli governing the physical or chemical activities of the bone cells are not definitely known.

2. Many of the general factors influencing these local stimuli are known and are very complex.

3. Further knowledge of the physiologic growth of bone can be had by experimental studies and the proper correlation of longitudinal as well as cross-sectional studies.

FACTORS IN ATROPHY OF BONE*

By J. ALBERT KEY, M.D., St. Louis, Mo.

IN a consideration of the causes of bone atrophy, it is necessary to emphasize the fact that bone, while it may be almost stonelike in hardness, is a living tissue, capable of undergoing changes in form and structure in response to either local or general influences. This is true not only of growing bone, but of adult bone as well, because, in the adult, the bone is constantly in a process of resorption and replacement, and the maintenance of the normal bone structure is dependent on a delicate equilibrium between these two processes.

If we use the term "bone atrophy" in its broadest sense, we must apply it to all of those conditions in which the total amount of earthy matter in the given bone is less than normal. Consequently, the term does not necessarily imply that there has been an actual decrease in the

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*Read before the Section on Orthodontia at the Midwinter Clinic of the Chicago Dental Society, Jan. 15, 1930.

amount of earthy matter in the bone, as the subnormal condition may be due to the fact that there has been some retardation in the development of the skeleton. Thus, in order that the bone may be normal, we must have a normal bone anlage in the embryo, and there must have been a normal state of nutrition and function during the growing period and in adult life.

Bone atrophy may be general, in that it affects the entire skeleton; or local, in that it affects only one bone or the bones in a certain portion of the body. As distinguished from atrophy, the term "bone absorption" should be applied to those changes which affect not the whole bone, but only certain regions, and results in the creation of gross defects in bone. In this paper, I shall discuss the cause of both general and local bone atrophy and the causes of bone absorption.

GENERALIZED BONE ATROPHY

In generalized bone atrophy, the entire skeleton is affected, and the condition is practically always due to some nutritional defect or metabolic disturbance. It is of especial interest to orthodontists because atrophic bone tends to bend under forces which would not affect normal bone, and this is especially true of growing bone where generalized atrophy may result in deformities of the jaws and malocclusion of the teeth. The chief forms of generalized bone atrophy are: (1) hypoplasia of the mesenchyme; (2) hunger osteomalacia; (3) marasmus; (4) biliary or pancreatic fistulas; (5) hyperthyroidism; (6) hyperparathyroidism; (7) true osteomalacia; (8) osteomalacia of pregnancy; (9) rickets; (10) scurvy, and (11) senile atrophy.

1. *Hypoplasia of the Mesenchyme.*—As an example of a subnormal skeletal system due to some developmental anomaly, we have the group of conditions variously known as hypoplasia of the mesenchyme, osteogenesis imperfecta, brittle bones and blue sclera, and osteopsathyrosis. In these individuals, the bones have approximately the normal form, but are usually more slender than normal and break easily. The condition is due to some as yet unknown deficiency in the formation of the white fibrous tissue of the body. In certain cases, it is hereditary and is transmitted by either parent as a dominant hereditary character.

2. *Hunger Osteomalacia.*—Other general bone atrophies occur as a result of postnatal conditions. The simplest of these, perhaps, is the osteomalacia of hunger. Until recently, most of our knowledge of this form of bone atrophy has been dependent on observations on animals which have been kept for a long time on a diet poor in calcium. It is known from these observations that animals or birds, if fed for a long time on a diet which contains insufficient calcium, gradually develop a state of rarefaction of the bones which continues to progress as long as the diet is continued. This type of atrophy is due, not to a deficiency in vitamins, but to the fact that, in a normal individual, there is a constant excretion of calcium, which is, within certain limits, independent of the calcium intake. In other words, just as we have a constant amount of nitrogen and carbohydrate used up by the living organism, so do we have a constant amount of calcium. If the amount of calcium in the food is insufficient to provide the amount necessary for metabolism, the calcium is withdrawn from the skeleton, which serves as the great storehouse or reservoir of calcium, and the calcium balance becomes negative, that is to say, more calcium is excreted than is absorbed.

Sherman has shown that the amount of calcium necessary to maintain a positive balance in the average adult human being is approximately 1 gm. a day. He has further shown that the usual dietary in civilized communities contains little more than 1 gm. of calcium a day. Consequently, civilized man exists on a rather close margin of safety as regards calcium, and if a person consumes a dietary which contains relatively large amounts of meat and starchy foods and relatively small amounts of milk, vegetables and fruits, that individual will have a negative calcium balance and will excrete more calcium than he absorbs. The reason for this is that, in order for the metabolic process of the body to be carried on, a certain amount of calcium is necessary in the blood, and this varies within narrow limits. The normal blood calcium is from 9.5 to 12 mg. per hundred cubic centimeters of serum. As a portion of this is constantly being lost, the level of the blood calcium is maintained in the presence of a negative calcium balance by the slow withdrawal of calcium from the bones.

Aub and his co-workers have recently shown that this calcium is withdrawn from the trabeculae in the cancellous bone, and that if an animal is maintained for a long time on a diet which is so low in calcium that the calcium balance is negative, there is a gradual disappearance of the trabeculae in the cancellous bone. From these observations, they have been led to the conclusion that the trabeculae represent a calcium reserve, the object of which is the maintenance of the normal blood calcium. I am of the opinion that calcium is withdrawn not only from the trabeculae, but also from all of the skeletal system. It would be necessary for the cortical bone to lose a much larger amount of calcium than the trabeculae in order that this loss might be evident.

In the period following the World War, many cases of hunger osteomalacia occurred in the central European countries where the great majority of the population were unable to obtain proper food and subsisted for a long time on a diet which was inadequate in calcium. The bone atrophies which occurred were general in type and differed from those of rickets in that they affected both adult and growing individuals, and also in that they could be promptly relieved by the supplying of necessary calcium in the food. There was a general softening of the bones throughout the body, with development of rheumatic pains in the spine and extremities, and the roentgen rays revealed both eccentric and spotty bone atrophy. On microscopic examination, these bones, especially in growing individuals, were found to contain a variable amount of osteoid tissue, or newly formed calcified bone.

3. *Marasmus.*—Closely akin to hunger osteomalacia are the bone atrophies observed in marasmus. In this condition, which occurs in infancy, although adequate calcium may be supplied in the food, it is not absorbed through the intestinal tract. Consequently, the patient is on a negative calcium balance, and the bones tend to waste away just as though there were an inadequate supply in the food.

4. *Biliary or Pancreatic Fistulas.*—As regards the bones, a very similar condition may exist in patients or experimental animals with biliary or pancreatic fistulas. In these instances also, there may be an adequate supply of calcium in the food, but owing to the absence of the bile or pancreatic juices from the intestines, the food is improperly digested and the calcium is not absorbed. Consequently, the animal draws on the great calcium re-

serve in the skeleton in order to maintain the normal blood calcium level, and the bones gradually waste away.

5. *Hyperthyroidism.*—A somewhat similar bone atrophy occurs in long continued hyperthyroidism. Here, the bone absorption is supposed to be the result of the increased metabolism, but relatively little is known of this condition, and I am inclined to think that the muscular weakness and inactivity of the patient are important factors in its production.

6. *Hyperparathyroidism.*—Rather different in its mechanism is the bone atrophy which results from increased activity of the parathyroid glands. It is now well known that the internal secretion derived from the parathyroid glands has the capacity of raising the level of the blood calcium. In other words, whereas in the normal animal the serum calcium varies from 9.5 to 12 mg. per hundred cubic centimeters of serum, it is possible, by administering the hormone of the parathyroid glands, to raise this level to 15 or 20 mg. per hundred centimeters, and, in the presence of an increased blood calcium, there is an increased calcium excretion. Consequently, with long-continued hyperactivity of these glands and the constant maintenance of an abnormally high blood calcium, there is a definite tendency to withdrawal of calcium from the bones. Furthermore, it has been shown that the blood calcium is, within certain limits, independent of the calcium intake of the individual. This means, of course, that unless an unusually large amount of calcium is absorbed, the calcium balance will be a negative and a generalized osteoporosis will result. Many clinical cases have been observed in which the presence of adenomas of the parathyroid glands was accompanied by generalized osteoporosis, bone cysts or giant-cell tumors. The exact relation between the hyperactivity of the glands and the production of local bone lesions has not yet been worked out, but clinical evidence is accumulating which seems to indicate that it may be a definite causative factor.

7. *True Osteomalacia.*—This is a very rare and poorly understood condition in which there is a negative calcium balance during the active phase of the disease which is not influenced by the administration of calcium or of cod-liver oil. The condition may progress indefinitely and the bones may become so rarefied and fragile that they not only are unable to support the weight of the patient, but also may be broken by such small strains as turning over in bed. The osteoporosis is, of course, due to the constant withdrawal of the calcium from the bones, but the reason for this constant withdrawal is at present unknown. It is possible that it may be related to hyperactivity of the parathyroid, but this has not yet been demonstrated.

8. *Osteomalacia of Pregnancy.*—This osteoporosis, which is seen in women who have been on a relatively poor calcium diet during pregnancy and lactation, is to be distinguished from the very rare true osteomalacia mentioned above. As is well known, both gestation and lactation impose on the mother demands for an abnormal amount of calcium. This calcium is supplied to the fetus and to the mammary glands by the blood. If an insufficient amount is absorbed from the intestinal tract to supply the excess calcium, it is withdrawn from the bones, with the result that bone atrophy occurs. This type of so-called osteomalacia of pregnancy is promptly relieved by the termination of pregnancy or lactation, or by the supplying of an adequate amount of calcium in the food. The condition is more like hunger osteomalacia

than like true osteomalacia. It differs from the hunger osteomalacia in that it may occur on a diet which contains sufficient calcium for the maintenance of a normal balance in a nonpregnant or nonlactating individual.

9. *Rickets.*—This is a very common condition affecting only growing bones and especially the bones of young children. Apparently, it is entirely due to the fact that the amount of calcium or phosphorus, or both, in the blood is so low that deposition in the bones does not take place. Consequently, not only is there a failure in calcification of the newly formed bone, but there may be an actual negative calcium balance and withdrawal of calcium from the bones which are already calcified, with the result that the bones may become so softened that they can be cut with a knife and develop severe deformities as a result of static influences or muscle pull, and these deformities may persist after the disease has healed and the bones have hardened.

Apparently, the lack of calcium in the bones in rickets is not due to any disease of the bone itself, as it has been shown by Shipley, Kramer and Howland that rachitic bones, if placed in normal serum, will promptly lay down calcium *in vitro*. The fault, then, is obviously a lack of calcium in the circulating fluids, and it has been shown that, in active rickets, the calcium or phosphorus in the blood serum is abnormally low. This condition may exist in the presence of an adequate supply in the food, and it has been shown in the growing child, not only that is it necessary to supply calcium in the food, but also that this calcium will not be absorbed by the blood unless there is also an adequate supply of vitamin D. This vitamin may be obtained through sun rays, ultraviolet radiation, cod-liver oil or irradiated ergosterol. Consequently, the condition of rickets differs from that of osteomalacia in that it can be promptly cured by supplying the deficient vitamin and calcium; while hunger osteomalacia can be cured by supplying calcium alone, and true osteomalacia is not influenced by the supply of either calcium or the vitamin.

10. *Scurvy.*—Here, a generalized bone atrophy develops as a result of cessation of formation of new bone. This lack of new bone formation is not due to a calcium deficiency or to an absence of osteoblasts, as the blood calcium is normal and the osteoblasts appear to be even more numerous than normal; but apparently, in scurvy, the cells are unable to form the intercellular material which is necessary as a matrix in which the calcium can be deposited. It is also probable that there is some disintegration of the organic matrix of the formed bone with resorption of the calcium which is thus freed. This disintegration of formed tissue is especially marked around the teeth and causes them to be loosened. The condition is promptly cured by the administration of the antiscorbutic vitamin, C.

Whether or not the lack of vitamin C is an important factor in the decay of teeth is a question which is at present under active discussion. Howe and others have produced caries in animals on scorbutic diets. Recently, Jeans and his coworkers have reported observations to the effect that they have been able to control existing caries in children by simply placing them on an adequate diet. This, of course, brings up the question as to whether or not uncleanliness or inadequate nutrition is the cause of tooth decay. I am of the opinion that either or both may be the cause. In other words, teeth should be both clean and properly nourished in order that they may remain intact.

11. *Senile Atrophy.*—Finally, a brief mention should be made of the generalized atrophy of bone which occurs to a variable degree in old age. This affects particularly the flat bones, such as the skull, pelvis and shoulder blades, and they are especially involved in areas where muscles are not attached and the bone absorption may progress to such a degree that gross defects are created in these bones. The alveolar processes may so waste away that the teeth loosen and fall out, and the jaw may become so porous that it is broken by chewing. The frequent fractures of the hip and of the upper end of the humerus and lower end of the radius in old people are largely the result of the senile atrophy, which is prone to affect the cancellous bone in these regions.

The cause of senile atrophy is unknown. It may exist in the presence of adequate nutrition and in an individual who is otherwise in apparently good health. Cohnheim regarded it as a physiologic change, such as affects the thymus, ovaries and certain other organs with age and causes the cells to gradually lose the ability to reproduce themselves. Recklinghausen considered it a nutritional disturbance and not a true atrophy. It has also been considered neurotrophic in origin. What really happens is that the equilibrium between the bone absorption and new bone formation is upset and the absorption gradually predominates. Not only is there a progressive loss of bone substance on account of this negative balance, but there is some deterioration in the quality of senile bone. This was demonstrated by Wertheim, who showed that small cross-sections of bone from old individuals were only about half as strong as similar sections of bone from young individuals. This relative weakness is not due to a lack of calcium in the senile bones, but is the result of some deterioration in the fibrous matrix which is responsible for the toughness of bone.

LOCAL BONE ATROPHY

Atrophy of one or more bones may occur in the presence of the maintenance of a normal state of equilibrium or of growth in the remainder of the skeleton. This local bone atrophy is not due to any general nutritional or metabolic disturbance, but is due to some local condition which affects the bone in question. The chief forms of localized atrophy of bone are those due to (1) disuse, (2) inflammation and (3) traumatism.

1. *Atrophy of Disuse.*—In the living organism, bone exerts a function which may be said to be passive in that it consists of resisting mechanical forces. Generally speaking, function within physiologic limits, alternating with periods of rest, tends to cause an increase in the size and function of a living organ, while inactivity tends to result in atrophy. Consequently, if the mechanical forces are removed, the function of the bone is lessened, and we may expect the bone to atrophy.

In the practice of medicine and surgery, we constantly meet with instances of local atrophy of bone which are due to disuse. This is especially true in orthopedic surgery when we are dealing with cases in which the bones, either because of paralysis of muscles or of some deformity or disease, have gone for long periods without performing their normal function. Particularly striking are the cases of infantile paralysis in which severe loss of muscle power has occurred in early life. In these cases, the bones which are controlled by the paralyzed muscles are not only much smaller and more fragile than normal, but they may be several inches shorter than normal. This means

that the normal tone of the muscles exerts forces which tend to stimulate the bones to normal growth and that, in the absence of this stimulation, the growth is inhibited. In cases of adult bone, after paralysis we have the same general phenomena, and the bones become rarefied and slender, but do not shorten.

Likewise, if an extremity is immobilized over a long period, there is gradual rarefaction of the bones of the part. We believe that this rarefaction is due to a progressive resorption of the bone substance by osteoclasts, but we are totally ignorant of the manner in which the osteoclasts are stimulated to carry on their destructive processes. We do not even know whether or not the atrophy of disuse is due to an increased rate of resorption or to the normal resorption and a decreased rate of new bone formation. As has been stated above, the maintenance of normal bone structure is the result of an equilibrium between these two processes.

It has been said that atrophy of disuse is due to an increased circulation in the bone, but it has not yet been proved that disuse is accompanied by any increase in the circulation. As a matter of fact, we should expect the circulation to be less than normal, but we have no evidence that the rate of circulation has any influence on the production or absorption of bone.

Likewise, in certain instances, when the mechanics of the part are altered and a bone is called on to perform a new or altered function, the living bone has the power of rearranging its structure to meet the new conditions. This is accomplished by a progressive resorption of those portions of the bone which are unnecessary and a progressive deposition of bone to meet the requirements of the new forces. Such rearrangement is beautifully illustrated in bones which have become curved as a result of rickets. In these bones, the concave side of the cortex, which is called on to bear the principal weight, becomes thickened, while the convex side becomes thinner than normal. Likewise, in fractures with overriding of fragments, the projecting portions of the bones tend to be gradually resorbed and the remainder becomes slowly reorganized according to the principles of Wolff's law. According to this law, the form and architecture of the bones are such that, with the use of as little bone material as possible, they are mechanically adapted to resisting the forces which are brought to bear on them. Thus, not only may we have an atrophy of disuse which affects the entire bone, but we may also have a local atrophy of disuse which affects any portion of a bone that loses its passive function of resisting mechanical forces.

2. *Inflammatory Atrophy.*—Rather difficult to distinguish from the atrophy of disuse is that atrophy which occurs in the presence of acute or chronic inflammation. It is not absolutely possible to say that we have a true bone atrophy in the presence of acute inflammation, but most surgeons who deal with inflammatory conditions of the extremities are quite definite in their own minds that, with infection in a hip, knee or ankle, there occurs an atrophy of the bones of the involved extremity which progresses with greater rapidity than could be accounted for by the amount of disuse incident to the infection. This is particularly true in tuberculosis, and I have seen cases of tuberculosis of the hip in which the atrophy of the bone was so extensive that not only had the cancellous bone disappeared and the cortex become exceedingly thin, but the roentgen ray also showed gross punched-out defects in the cortex

of the femur which so resembled the defects created by malignant tumors that we performed a biopsy on the bone in order to determine whether or not the patient had a multiple myeloma with destruction of the bone. The biopsy revealed simple bone atrophy.

These inflammatory atrophies also occur in acute infections such as osteomyelitis, and are particularly pronounced in acute pyogenic infections of joints or in gonorrheal infections of joints. Likewise, in chronic proliferative or atrophic arthritis, one of the outstanding characteristics of the disease is the tremendous atrophy of the bones entering into the involved joints. Whether or not these various inflammatory atrophies can be explained on a basis of the immobilization incident to the infection is doubtful. I believe that the presence of inflammation inaugurates some change in the metabolism in the surrounding tissues which leads to increased resorption of bone. What this change is, we do not know.

3. *Acute Traumatic Atrophy.*—Quite similar to the atrophies which occur in the presence of inflammation are those which occasionally follow an injury. These were first described by Sudeck and have become known as Sudeck's bone atrophy. This is a rapidly progressing osteoporosis which involves the bones of an extremity that has been subjected to some injury. The injury may have been a severe crushing fracture or merely a slight sprain or contusion. After the injury, the parts distal from it remain swollen, tender, cold and cyanotic. The joints become stiffened and painful on motion, and the surgeon is at a loss to explain the failure of restoration of function in the part, although the bones, if broken, tend to heal normally. A roentgenogram taken two or three months after the injury in such a case will reveal marked osteoporosis, which may be spotted in character. This condition may persist for many months and eventually result in a gradual restoration of normal bone structure and resumption of function. In severe cases, I have found the blood calcium to be normal, which indicates that the condition is not due to a general metabolic disturbance.

Many theories have been advanced to explain this acute posttraumatic atrophy of bone. Sudeck regarded it as a reflex neurotrophic phenomenon, but has not yet been able to explain how this is brought about. At the same time, no other explanation for the condition is acceptable. It has not been produced experimentally and occurs only in rare instances, and most individuals with similar injuries fail to develop the condition.

LOCAL BONE ABSORPTION

As distinguished from atrophy of whole bone, we have a process of absorption which affects only a portion of a given bone and results in the total disappearance of the area involved. This absorption may be due to (1) pressure, (2) neurotrophic disturbances or (3) cellular activity.

1. *Pressure Absorption.*—In the case of pressure, it may be accepted as proved that if the force which a bone is called on to resist is increased, the tendency of the bone is to hypertrophy and become stronger. This would indicate that pressure tends to cause bone hypertrophy rather than absorption, and we have abundant evidence of this in the readjustments occurring in deformed bone. The most familiar of these is the thickening of the concave border of bones, which have become bent as a result of softening due to rickets and then subjected to weight bearing.

On the other hand, we have frequent examples which tend to show that abnormal pressure may cause the erosion of bone. One of the most familiar examples of this is the erosion of ribs, sternum or vertebrae by an aneurysm. Other instances are the grooving of bones by tendons, the basilar impressions of the skull and the erosion of the skull by pacchionian bodies. So striking are some of these that Volkmann was led to say that, in spite of its hardness, bone is more susceptible to pressure than are the soft tissues.

It is difficult to understand how an aneurysm exerting a pressure of 100 or 200 mm. of mercury can eat its way through bones, while, in a case with dislocation of the hip in which the patient has been walking over a long period of years with the weight of the body transmitted through the head of the femur to the side of the ilium, the abnormal pressure causes, not erosion, but hypertrophy of the underlying bone. In such -in stances, it cannot be a question of the amount of force exerted as this obviously is much greater in the congenital hip condition, nor can it be the duration of the force as was thought by Schmidt, as this is also longer in the case of the hip. Roux believed that the direction of the force was important and that pressure on a periosteal covered surface causes atrophy, while that on a surface covered by cartilage does not. The case of the hip disproves this as the pressure is lateral to a surface which is not normally subjected to pressure and which is covered by periosteum.

Jores attempted to solve the problem in an ingenious manner. He strapped rubber bags of mercury or water to the backs of guinea-pigs and rabbits and then studied the spinous processes. The experiments lasted from thirty to sixty days and, in some instances, the pressure was applied intermittently. He found no macroscopic changes, but, from his histologic studies, concluded that bone resorption occurred during the period of pressure and that bone repair and hypertrophy occurred during the intermissions when the spines were free from pressure. This is a very attractive theory, but it is disproved by the case of the hip, because here we have an area that is practically never free from pressure, as the normal muscle presses the femur against the ilium when it is not bearing weight, though of course the pressure is not so great. Furthermore, in operating in cases of tuberculosis of the spine with a kyphosis, I have often noted that the tips of the spinous processes over the kyphos are unusually broad and hard. The patients had been recumbent for some months, and the prominent spinous process had been subjected to an unusual amount of pressure during that period and had become hypertrophied.

On the other hand, dental surgeons are familiar with the fact that malocclusion of teeth may cause absorption of bone in the alveolar process at points where the malocclusion tends to press the tooth unequally against its surrounding bone. This, of course, is evidence that we may get absorption of bone by pressure which is intermittent because the pressure is active only during the brief periods when the teeth are pressed together. Consequently, we find that, generally speaking, the amount, duration and constancy or intermittent character of the pressure have not been shown to explain the atrophy or hypertrophy which occurs in bones when they are subjected to abnormal pressure.

Having admitted the foregoing, we should qualify it by stating that there are, of course, limits to the amount of pres-

sure which bones can stand and that this is considerably less in atrophic bone. In exerting traction by means of pins passed through bones, we not infrequently find that, in the case of atrophic bones, the pin hole may be enlarged in the direction of the force as a result of the bone absorption from pressure exerted by the pin.

A further example of the resistance of living bone to pressure is found in those cases of chronic arthritis in which the cartilage has been eroded from the ends of the bone and the bones have borne weight over a period of years. Not only have they borne weight, but they have been subjected to friction during much of this period. These bones are not eroded, but the surface region becomes hard and ivory-like in consistency and takes a high polish. On the other hand, in the case of the hip, if there is a fracture through the neck of the femur, with nonunion, we frequently find that that portion of the neck which is connected with the shaft rapidly wastes away, partly, perhaps, as a result of pressure; while that portion which is attached to the head and apparently dead not only does not disappear, but also tends to retain its normal density.

2. *Neurotrophic Absorption.*—A somewhat special type of pressure atrophy of bone is found in Charcot joints. Here, we are dealing with a disease of the central nervous system, usually syphilitic in origin, in which there is destruction of some of the sensory nerves to the part. Whether or not true trophic nerves exist is a moot question, but we do know that something has happened to the bone of these joints which renders it much less resistant than normal to the trauma incident to function, and that, as a result, the ends of the bones may be rapidly eroded. Since there is no diminution in their mineral content, we believe that this is due to some change in the quality of the organic matrix of the bone.

3. *Cellular Absorption.*—The erosion of bone by living cells which occurs in inflammatory processes and in the presence of tumors is thought by many to be the result of pressure and is explained by growth pressure, because as the cells in inflammatory areas multiply and the blood vessels dilate, they must exert a certain amount of pressure on the surrounding bone. It seems to me that this pressure is much less than would be necessary to account for an actual destruction of the bone, and I am inclined to believe that the erosion is accomplished by means of the cells themselves in some chemical manner rather than by simple growth pressure. In an abscess of either tuberculous or pyogenic origin, as long as the bone is living, the abscess cavity can become enlarged by the progressive destruction of the surrounding bone. A good deal of this is accomplished by osteoclasts, but apparently some of it is also accomplished by the cells of the walls of the blood vessels and by the young fibroblasts. A peculiar thing about the effect of pressure on bone is that, if the bone is dead, pressure has relatively little effect. In other words, in the case of infection, if a sequestrum is formed, this will remain intact, and while it may be very slowly absorbed over a long period of years by the giant cells, the living tissues cannot attack it with anything like the speed with which they erode living bone.

CERTAIN PHASES OF DENTAL ECONOMICS*

By C. N. JOHNSON, L.D.S., D.D.S., Chicago, Ill.

THE question of dental economics is just now prominently before the profession. In fact, it has been discussed at varying intervals ever since there began to be organizations in dentistry, for the simple reason that it enters so vitally into the material needs of the members of our profession. It is well that we should give a reasonable amount of study to the business management of our affairs, because we owe it to our families or those dependent on us to make provision for the proverbial rainy day which is supposed to be in prospect for every one of us. To do less than this is to be remiss in a certain duty which devolves on every individual who comes to years of responsibility, and who wishes to preserve his self-respect. But there is always a grave danger that this phase of our professional life will be magnified to the exclusion of the strictly professional and ethical interests of our occupation, and the moment this is done, it will start us on the straight road to commercialism, and to deterioration as a profession. It is always a nice thing to preserve the proper balance between sane business methods and those ethical ideals which have been the direct means of placing dentistry in the line of professional recognition. Today, we have the proud distinction of being classed with the learned professions, and we shall maintain this status only by the strictest adherence to the rules of ethical conduct which have always characterized professional life and made a distinction between it and the pursuit of a trade or a commercial enterprise. But if we are basicly honest with ourselves and with the profession, we shall be able not only to preserve our ethical birthright, but also to so protect our material interests that we shall approach the so-called "sere and yellow leaf" with the utmost equanimity, and with the satisfaction that we shall never be dependent on anyone else. If, in this paper, I seem to emphasize the necessity for the closest attention to the business side of dentistry, it is not because I deem it the most important side, but because, in the economic developments of the age, I think that it is essential for every self-respecting citizen—professional man or otherwise—to conserve his material welfare and provide himself with the refinements of the age so that he may get the fullest possible measure of enjoyment out of life, and do the greatest good.

The very first essential for successful business in professional life is to attract patients. Without a plentiful supply of patients, a practitioner can never achieve business success, and the ability to gain patients and hold them forms the first requisite or the real foundation for financial prosperity. I am perfectly aware how impractical it may sound when I say that it is largely an individual matter to attract patients and hold their confidence, but it is a simple fact that personality goes a long way toward achieving such

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an influence with people that they will wish to go to a dentist and remain his patients. By personality, we mean all of those attributes of gentlemanly demeanor which go to mark the difference between the cultured man and the uncouth or slovenly individual who cares little for the ordinary amenities of life. Before an audience such as this, it is deemed unnecessary to treat, as one would with students, the matter of habits in connection with professional success, and yet no discussion of economics should ever be considered complete without reference to the definite and intimate effect of personal habits on a man's ability to attract patients. The intimate relationship that must exist between patient and operator makes it incumbent on the dentist who wishes to succeed to so guard his personal habits that he shall never in any way be objectionable to his patients. Of course, it should be unnecessary to say that cleanliness in every sense of the word should be the basis of his professional conduct. In this age, no man need expect success unless he is scrupulous in this respect, and yet we see a goodly number of dentists who are careless as regards both their person and their surroundings. Dentistry is very exacting in this particular, and many a man has made wreck of his prospects by ignoring this fact.

CHARACTER OF SERVICE

Proficiency in the practice of dentistry is an essential in achieving a permanent success. Unless a practitioner can insert fillings that will last or dentures that are satisfactory, he cannot hope to retain his patients, and there is only one cure for inefficiency. The moment a man recognizes his limitations in any line of work, he should at once apply himself to study or postgraduate work in order to remedy the deficiency. Stagnation is the greatest enemy of progress, and, in professional life, it is almost deadly. There seems to be an inconceivable tendency for dentists to get in a rut, and this accounts for many a failure. If the average run of dental operations gave a longer tenure of service, and if dentists accomplished their work with less discomfort to the patient, the aggregate of dental operations performed would be much greater than it is today, and thus the economic situation among dentists would be improved. Dentists do not sufficiently consider this factor of their economic problems. To be a good operator and to gain the reputation of accomplishing results with a minimum of pain or inconvenience is a real asset in dental practice, and the more securely a man can bind his patients to him in loyalty and confidence, the better his prospects for economic success.

But let us grant a man the ability to deliver good service to his patients: there is yet another angle to his financial success. An operator may be able to do good work and take care of his patients acceptably and yet be an economic failure. It is one thing to operate well and to fill the time with appointments: it is another thing to make the time profitable. And here we encounter one great reason that many operators fall short of economic success.

WASTE TIME

I sometimes think that the waste of time in the average office constitutes one of the greatest economic leaks, and I have been surprised that the members of the profession have not checked up on this matter more carefully. There are several ways of wasting time, one of which is the lack of system in operating whereby there is so much false motion that, in the aggregate, many hours are spent without commensurate accomplishment. Hunting for the right instrument needlessly con-

sumes much time; the instrument should always be in its proper place so that it would not need to be hunted. Fumbling around among instruments and appliances without a clear cut idea as to what is required for a given operation is a pure waste of time; the operator should so plan his work and so train himelf in system that he knows in advance precisely what he wants to do and how to do it. Precision means much in the saving of time as well as in the impression made on the patient. It at once inspires confidence to see an operator go straight to his work as if he were thorough master of the situation, and did not have to hesitate about what should be done.

Another grievous waste of time is encountered in consultations without charging a fee. This is a custom that has been handed down to us from our predecessors, and to remedy it is a very difficult matter. Only by a reasonable concert of action can we hope to so train the people that they will respect our time and recognize it as having any value. But this is something that will be corrected gradually as the people are educated to the fact that it has cost the dentist effort and money to acquire the knowledge that he is dispensing for their benefit, and that he is as much entitled to compensation for his opinion and time as is the physician or lawyer. Every one of us has been remiss in his duty to the profession by contributing to the idea that it is proper for a patient to slip into an office and take a dentist's time and his opinion and walk out again without remunerating him—frequently, without even thanking him. We cannot expect to command or retain the respect of people when we permit them to impose on us in this manner. It is not so much the fault of the people as it is that of the profession that such a condition exists, and it is not so much the fault of the present generation of dentists as it is that of those who have preceded us; and, as a matter of fact, it is not so much the fault of any one as it is the natural concomitant of a practically new and developing profession. It requires time and effort to establish a professional status in the eyes of the public, and we must all unite to bring this about in the matter of compensation for consultations.

Another element of loss relates to broken appointments. In this, the people are better trained than formerly, and we do not suffer the same abuses that prevailed at one time. It required the same stand on the part of the profession to correct this dereliction and compel patients to respect our rights as it will to remedy the matter of compensation for consultations. Not till dentists made it a rule to charge for broken appointments did the people awaken to the equity of the matter and begin to respect the obligation involved in an appointment; and not till we as a united body force our rights in the matter of consultations shall we receive the proper recognition of our side of the question.

In the matter of treatments, we have in the past given altogether too much service gratis, but in this, as with broken appointments, there is a great improvement. We still give too much time to treating teeth without adequate compensation, but there is at least a recognition of the equity of charging for treatments, and this is a real advance over previous custom. It has frequently been emphasized that time is the dentist's capital, and the more we study and apply the rules for saving time and for making all of our time remunerative, the more secure will be our economic structure.

FEES

The subject of dental economics can never be discussed without a consideration of the perennial question of fees. It always seems to loom large as the one outstanding problem with which the professional man must cope. It is really the acute point of contact between the patient and the practitioner, and it requires constant education of the people and constant consideration of the profession to harmonize points of view and make our economic machinery run smoothly. A great deal has been written on this subject, much of it to no purpose whatever, owing to the fact that fees must, in the very nature of things, be regulated largely by individual circumstances which cannot apply universally. In other words, it is a matter which must, for the most part, be settled by each operator in the light of the conditions which confront him.

This does not mean that the equity of the fees prevailing in the profession generally can be altogether ignored by the individual dentist. While he must largely "work out his own salvation" in the regulation of his fees, he cannot or should not disregard entirely the customary fees in his vicinity. There is one thing connected with dental fees generally that we must recognize: that relative to the benefit rendered to patients and the amount of physical and nervous energy expended on our part, the compensation we receive is not too great; in fact, in most cases, it is much too small. There are many considerations that bear out this statement, and this is another matter on which the public needs education. This, of course, has reference only to those cases where good service is rendered, and not to those occasional instances where a high fee is exacted for indifferent work. Exploitation has no place in a professional pursuit, and it should be frowned on by all self-respecting dentists.

Reference has been made to the fees prevailing in any given community and to the necessity for considering them to a certain degree in regulating one's individual fees; but there is one thing that is fatal to economic success and that is to charge fees that are notably lower than those in vogue in the vicinity. The appeal of low fees never leads to permanent prosperity on the part of a professional man. It is not merely that he has to work harder and for longer hours to earn an adequate income, but also that the lure of low fees attracts to him the type of people who are neither satisfactory nor stable in their patronage. The shopper is the abomination of professional life, and no one ever built a substantial economic structure by catering to this class. A man may gain the reputation of charging a little more than his colleagues, and this very fact may react to his advantage provided he gives full value in service for the fee charged, but he cannot afford to have it rumored that he charges low fees, because of the general demoralization that such a rumor brings to his practice and the class of people that it attracts, if, indeed, it ever attracts any.

For demanding and obtaining a just fee, there is one prime requisite, and that is first to have a settled conviction in the mind of the practitioner, backed up by the utmost conscientiousness that the fee asked is a perfectly legitimate one. Unless a man believes in his own heart that he is entitled to a certain fee, he can never demand it of his patient in such a way as to impress the patient with its equity. A conviction of this kind creeps into the bearing of the operator and is transmitted to the patient more by the general demeanor of the dentist than it would be by too much argument. One

thing is essential: it is not enough to be assured in your own mind that you are entitled to a given fee, but this conviction must be transmitted to patients in such a way that they are made to see its equity and are convinced that you are perfectly just in your demands. This mental attitude on the part of the patient must first be secured before complete harmony and pleasant relationship is achieved, and without this, no professional practice is successful or satisfactory. A man must have confidence in himself before he can expect other people to have confidence in him, and that confidence must be founded in a settled conviction and a firm determination to be honor bright in all of his dealings.

Speaking of argument calls to mind one cardinal principle of conducting a practice and establishing a satisfactory economic future, and that is to avoid, at whatever cost, any unseemly wrangling with patients. It is, of course, beyond the bounds of probability to go on year after year handling all types of people without at times finding oneself at cross purposes with certain individuals; and yet in professional life it is always demoralizing in the extreme to give way to intemperate argument or, in fact, to a display of temper of any kind. You can stand on a legitimate conviction in a frank and dignified way in the face of all the world and thereby preserve your sovereignty of soul, but you cannot stoop to controversy and contention without sinking your manhood and losing prestige with those whose good opinion is worth having. To argue and jangle with patients is to lose their confidence and respect and, what is infinitely worse, it is to lose your own self-respect. If you are hot tempered, take yourself in hand this very minute and gain control of yourself; otherwise, you cannot hope to control others; and remember this: that one of the essentials in a successful professional practice is to be able to control other people.

If disputes arise over bills or for any other cause, always assume the attitude of toleration and reason and try in every way in your power to see the other man's point of view. Contend for a principle if need be, but do not stoop to pettishness or selfishness in trying to gain your point. To suffer the reputation of being quarrelsome is a distinct handicap in the management of a practice, and it does not contribute to the harmonious settlement of disputes; but to gain and keep the good will of people is a real economic asset. No man can successfully carry on his affairs without a great deal of good will, and the means of obtaining it are so simple that every one should avail himself of this privilege.

OVERHEAD

There is one item that has directly to do with economic success, something that too many men in the profession utterly fail to consider, and that is the overhead expense of conducting a practice. On making inquiry about this matter, I have been amazed to find the number of dentists who keep no detailed record of their expenditures, and who, before the income tax became operative, made no record of any kind. This is not good common sense, and there is no excuse for such unbusinesslike methods. Many a man has made shipwreck of his business affairs through carelessness of this kind, and there is no possible justification for it. When this matter is studied in a methodical way, it is found that the overhead of many men is altogether too great for their income. In a more or less restricted business enterprise such as a dental practice, which is so largely a matter of personal service, an overhead

of 30 or 40 per cent of the gross income should be ample; but I have been informed that, in some instances, it runs as high as 60 per cent. This is wholly unjustifiable unless the volume of income is much greater than that of most dentists, with the possible exception of certain group offices. Overhead can take many fantastic forms of extravagance, and it is a very easy matter to let it run away with a man's judgment unless he keeps a constant check. I sometimes think there is a tendency toward extravagance among professional men; at least, there is a lack of judgment about their expenditures. In the first place, they waste materials without warrant, and dental materials are expensive. They buy many things that they do not need, and they sometimes embarrass the dental dealer by not being able to pay for them in a reasonable time. A good equipment is, of course, necessary for conducting a modern practice, but any equipment is ill advised that costs beyond the ability of the purchaser to pay in a legitimate credit period. Too many dentists make purchases without counting the cost, or at least without considering whether or not they can afford it. There is something wrong with the management of a practice that keeps the operator continually in debt. A man should aim to get ahead of the game and stay ahead.

A dentist should at stated intervals, sometimes at the end of every month, and at least yearly, go carefully over his expenditures and his income and compare the two, to see not only where he stands but also what progress he is making. Some one has said that in the great experience of life, it matters not so much where the individual stands as it does the direction in which he is going, and I think the same idea applies to a dental practice. It matters more that progress is being made than it does to contemplate the present status. If the practitioner finds that his financial condition is not satisfactory or that the ratio of expense to income is illogical, he should at once make a careful study of his affairs and see where the discrepancy lies. Only by a periodic check-up of this nature can the practitioner stop the economic leaks that are likely to creep into every practice, and remedy the difficulty. There is always a remedy where the situation is not satisfactory, and the sooner the remedy is applied, the better. If a professional man gives sufficient thought to this matter, there is no reason why he cannot change an unprofitable practice into a profitable one, and find the balance sheet satisfactory at the end of the year.

COLLECTIONS

A truism often repeated is to the effect that it is not so much a matter of what you earn as it is what you collect, and it is in the question of collections that many dentists fail in their economic program. It is often a nice matter to be an expert collector and still retain the good will of people, but it can be done, if the business methods of the practitioner are established along the proper lines and the habit of rendering bills promptly is strictly adhered to from the beginning. Patients, if they desire the services of the dentist, quickly fall in line in the matter of payments, and the practitioner should adopt the most approved business principles of rendering accounts regularly on the first of the month, and then following them up in case they are not paid. Much has been written on this subject and much still remains to be learned, but the first essential is to make the patient realize that there is no laxity on the part of the dentist in rendering bills, and that payment is expected in a reasonable time.

The attitude of the dentist in these matters has much to do with the attitude of the patient, and many of the losses encountered by dentists have had their inception in indifferent methods of making collections. It is proverbial that the longer an account is permitted to run, the more difficult it is to collect it, and this should furnish a lesson in the prompt and regular rendering of accounts. Reference might be made to the practice of endeavoring to force payment in cases of long overdue accounts. While there are some instances in which radical pressure is required in the attempt to force collection for the disciplinary effect, the practice of suing for dental bills has never much appealed to me. I have seen very little justice done as the result of such suits, and as long as our courts are conducted as they are, I could not conscientiously advise any dentist to take a bill to court in the effort to force payment. There are, of course, exceptions to every rule, but I think that the rule should be to stay out of court.

Unquestionably, much more is lost than should be by the dental profession in bad accounts, but most of this is primarily the fault of the profession in their failure to inaugurate correct business methods. And yet it may as well be acknowledged that, in the exigencies of our modern life, it is almost inevitable for some losses to occur. People whose intentions are good sometimes suffer serious reverses unexpectedly, and there are many circumstances which may interfere with the payment of accounts that it is wholly without the power of the patient to prevent.

One thing should always be borne in mind: in case an account is for any reason irretrievably lost, there is not the slightest thing to be gained by lamentation. To weep over spilled milk has never done any good and has never yet brought back the milk. Under the circumstances, the dentist must learn to be a philosopher and accept his loss with the best grace possible. To learn to smile in the face of bad luck like this is really to get some compensation out of the situation; and assuredly nothing is to be gained by worrying and fretting. Men who conduct a practice or a business of any kind today must learn to be philosophic, and without this sublime lesson, life will lose much of its attraction. Do the best you can and let the matter go at that, but, above all things, do not waste your energy and incapacitate yourself by useless regret.

INVESTMENTS

No consideration of economics is ever complete that does not discuss the subject of investments. It is one thing to earn money and to collect it; it is another thing to so invest the money that it will earn more money. And it is the money earned by money that forms the basis for the really substantial estate. I have elsewhere gone rather fully into the subject of investments for dentists, and I must content myself at this time with a somewhat cursory consideration of the question. In May, 1923, I read a paper on this topic before the Nebraska State Dental Society, and in April, 1929, I read another before the New Jersey State Dental Society, in which I discussed in some detail what I deemed suitable investments for dentists. In 1903, I published a book on "Success in Dental Practice," which contained a brief chapter on the subject, and so I am abundantly on record with my views in the matter; yet I cannot resist begging your indulgence for a few minutes today to refer briefly to this important subject.

It is in the matter of investments that I think the profession has shown less judgment than in any of its other activities. The aggregate sums earned by dentists that have gone to fill the coffers of the wily promoter would be staggering if they were only known. It was at one time proverbial that professional men were so-called "easy marks" for exploiters of all kinds, and I doubt not that dentists have contributed their full share to the support of this class. But I really believe that this no longer holds true. I have said "at one time" because I am convinced that there has come over the members of our profession a very encouraging change in their attitude toward investments. In talking with brokers and bond men, I find that professional men are investing more generally in staple securities than in the past, and this means that they are investing less in speculative ventures.

I wish I could bring home to young men the fundamental folly of playing the market on a margin or indulging in "flyers" of any kind. I confess to a bit of sporting blood in my own veins, but I have never yet bet on a horse race, a prize fight or a bobtail flush. I always worked too hard for my money to step out of doors and deliberately toss it to the winds. I can get my fun some other way. I have never known a professional man to become wealthy and remain so by following speculative ventures. Speculation does not fit into professional life, and the man who attempts to combine the two usually comes to grief in both. Slow conservative investments, while less spectacular and alluring, always bring the greatest assurance of a comfortable provision for old age. Much might be said about the suitable class of investments for dentists, but the present paper is already too long.

CONCLUSION

I cannot close without a few general observations on the problem of economic success for dentists. I am convinced that this is largely a problem for each individual to work out for himself, but it can be done only by observing certain rules of the game that are fundamental. First is the fact that, in conducting a profitable practice, due consideration must be given the point of view of the patient. We may sit soberly down and work out on paper an alluring plan of profits. We can figure ourselves into a very attractive income with so much allowed for every hour of endeavor, and we may get up from our estimates with a smug sense of satisfaction that we have solved our problem. But we have forgotten one thing: we have failed to consider how our attractive plan is going to appeal to the patient, and it is on this appeal that the success or failure of any plan depends. At every stage of our economic progress, we must reckon with the point of view of the patient, and unless we can make that conform to our own, we shall not get very far with our plans. Equity must be the basis of all of our dealings with the public, and until we have learned to consider the welfare of others as well as our own, we are not very far on the road to economic success.

With a practice already established, it may be possible to institute almost any change we wish and "make them like it" for a time; but unless this change appeals to their reason, patients will not conform to it indefinitely: they will go elsewhere. And this has happened many times when dentists have sought to force their so-called reforms on their patients as the result of estimates made on paper. You may be able to lead horses to the trough for a time, but you cannot make them drink. In one of the papers just alluded

to, I made a statement something like this, to which I still subscribe: "No system of dental economics will ever succeed permanently that does not take into consideration the welfare of all parties to every transaction." I am firm in my conviction that this assertion is fundamentally true, and I hereby again submit it as one of the chief tenets of my professional and economic faith.

A CASE OF METASTATIC CARCINOMA OF THE JAWS*

By WILLIAM G. SKILLEN, D.D.S., Chicago, Ill.

ALTHOUGH most of the bones of the skeleton are frequently involved by tumors through metastasis, but few cases of invasions of the jaws by such growths have been reported. This is probably due more to the fact that the jaws are seldom examined than that such instances are rare.

The case to be discussed here was that of a woman, aged 40, whose death was judged as having been induced by carcinoma of the breast and anemia.

Although clinically there was no evidence that the jaws were involved, histologic examination revealed that both the maxilla and the mandible had been invaded to a large extent. In the former, the area involved extended from the right cuspid region to the left first molar; in the latter, from the cuspids on both sides of the jaw to the second molar regions. The incisor region in the lower jaw was not affected. The areas of the jaws most involved, possibly indicating the first point of invasion, were, in the maxilla, between the floor of the antrum and the apices of the teeth; in the mandible, between the base of the jaw and the apices of those teeth. Except in the right cuspid region of the maxilla, where the whole lingual alveolar process and much of the peridental membrane of that tooth had been encroached on, the invading tumor terminated generally somewhere in the apical third area.

Some of the relatively large veins in the neighborhood of the wall of the antrum, and in or near the mandibular canal, were almost completely filled with tumor cells. (Fig. 1.)

The tumor cells themselves were either cuboidal or polyhedral in form, their shape apparently depending on their arrangement in relation to each other and the surrounding tissues. Their arrangement varied somewhat at different levels of the tumor mass. Toward the periphery of the latter (Fig. 2), the cells were usually grouped in small nests or thin, two-layered strands surrounded by a considerable amount of a dense, fibrous stroma. Deeper in the mass, the tumor cells increased in number (Fig. 3), the groups of cells becoming larger and assuming in many places an irregular, alveolar-like arrangement. (Fig. 5.) The stroma gradually decreased in amount toward the deeper portion of the tumor mass. (Compare Figs. 2 and 3.) Thus, toward the periphery of the tumor mass, the large amount of fibrous stroma would

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make the tumor a scirrhous type; while, in the deeper portion, it had more the appearance of a fibromedullary type.

Both resorption and apposition of bone occurred, with, on the whole, the former predominating. No change, even where the peridental membrane itself had been invaded, could be found in the teeth. (Figs. 6-8.)

Resorption of bone was of a lacunar type, the lacunae of Howship being observable everywhere. (Fig. 5.) Typical osteoclasts were noticeably few in number. This seems to be quite characteristic of many tumor invasions of bone, and because of it, and the close relation which so often exists between the tumor cells and the resorption lacunae (Fig. 5), some writers apparently have been led to believe that the latter cells have the ability to destroy bone. Ewing[1] seems to mean something like this when he says that "within the bone, the matrix is resorbed, the tumor cells forming lacunae-like osteoclasts, dissolving the cancellous tissue." Axhausen[2] discusses the question, at the same time reviewing the opinions of v. Recklinghausen, Wolff, Götsch,[3] Ernst[4] and others, all of whom believe that the bone is resorbed either by the tumor cells themselves; through a process of dissolution or halisteresis, or by means other than the action of osteoclasts. Axhausen himself came to the conclusion that bone resorption is always lacunar and always occurs through the action of cells, virtually osteoclastic in action, although not always having the characteristic, multinuclear form of such cells. Hofer[5] also came to the same conclusion, saying, further, that when the tumor cells came to lie close to the bone, no further change took place.

In the material under discussion here, only a few scattered typical osteoclasts could be observed, these usually occurring well toward the periphery of the tumor mass. In general, the resorption lacunae were devoid of typical osteoclasts, being occupied by either fibrous tissue or tumor cells. (Figs. 6 and 7.) Usually, in the latter case, some fibrous tissue intervened between the tumor cells and the wall of the lacunae. (Fig. 5.) Now, Ewing[1] says that the new connective tissue cells, whose development accompanies the invading tumor, may bring about resorption, and Axhausen[2] describes single, spindle or half-moon shaped cells acting as osteoclasts in producing a lacunar resorption. Thus, it may be that some of the flattened cells in the fibrous tissue which occupied the resorption lacunae in this material, and which appeared to be fibroblasts, correspond to those cells described by the above-mentioned writers, and that much of the resorption seen in this instance had been produced by them.

As to the tumor cells themselves bringing about resorption, it was quite noticeable that, although in many areas the bone was closely surrounded by tumor cells (Fig. 3), no resorption had occurred. Resorption lacunae were also quite numerous in areas not yet involved by the tumor, and, as has been said, were

1. Ewing, James: Neoplastic Diseases, Ed. 3, p. 52.

2. Axhausen, Georg: Histologische Studien über die Ursachen und den Ablauf des Knockenumbaues in osteoplastischen Karzinom, Arch. f. Path. u. Anat., 195:358-459, 1909.

3. Götsch, W.: Ueber den Einlusz von Karcinommetastasen auf das Knockengewebe, Zieglers Beitr z. path. Anat., 39:218-249, 1906.

4. Ernst: Vershiedarten d. Knockenresorption durch Metastasen Malign. Geschwülsten. Verhandl. d. Deutsch. path. Gesellsch., 1901, p. 241.

5. Hofer, Otto: Alveolarknocken u. Zahn bei bösartigen Geschwülsten, Ztschr. f. Stomatol., 1925, p. 522-545.

not always occupied by such cells. This would indicate that the tumor cells played no particular, primary rôle in resorption, but rather that some other type of cell, if not indeed the typical osteoclast, was responsible for the change, and that it all occurred before the complete invasion of the tissue by the tumor mass.

In many areas where the bone was completely surrounded by tumor cells, instead of evidence that resorption had ever been going on, there were indications that bone formation had been in progress. Much of the old bone was covered by a thin layer of osteoid tissue. In the less involved areas, osteoblasts were sometimes observable, but where the tumor cells surrounded the bone closely, these could not be distinguished.

In some places also, a new, close-meshed cancellated bone, differing widely from the old, thick walled, wide-meshed

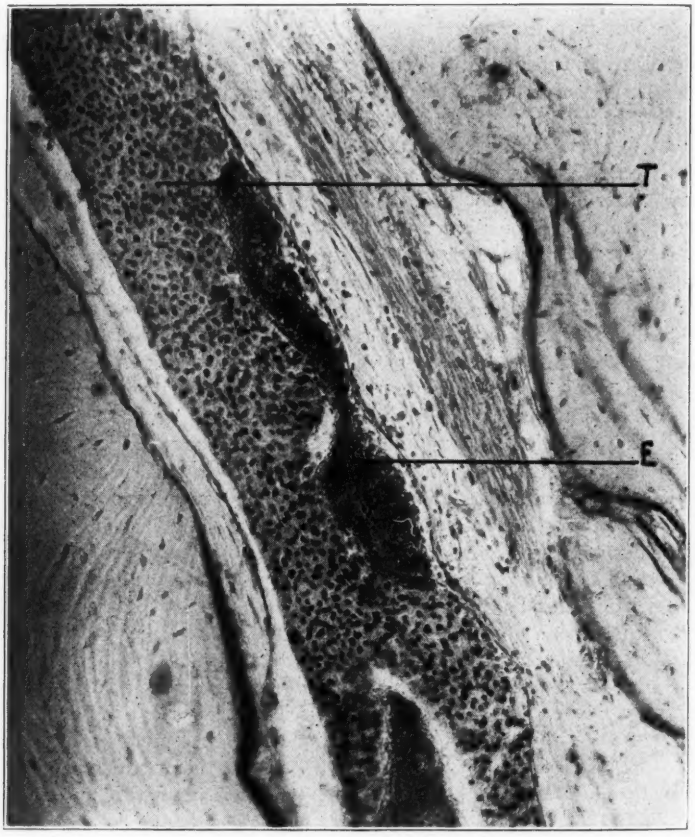

Fig. 1.—A relatively large vein filled with tumor cells, *T*. *E*, erythrocytes.

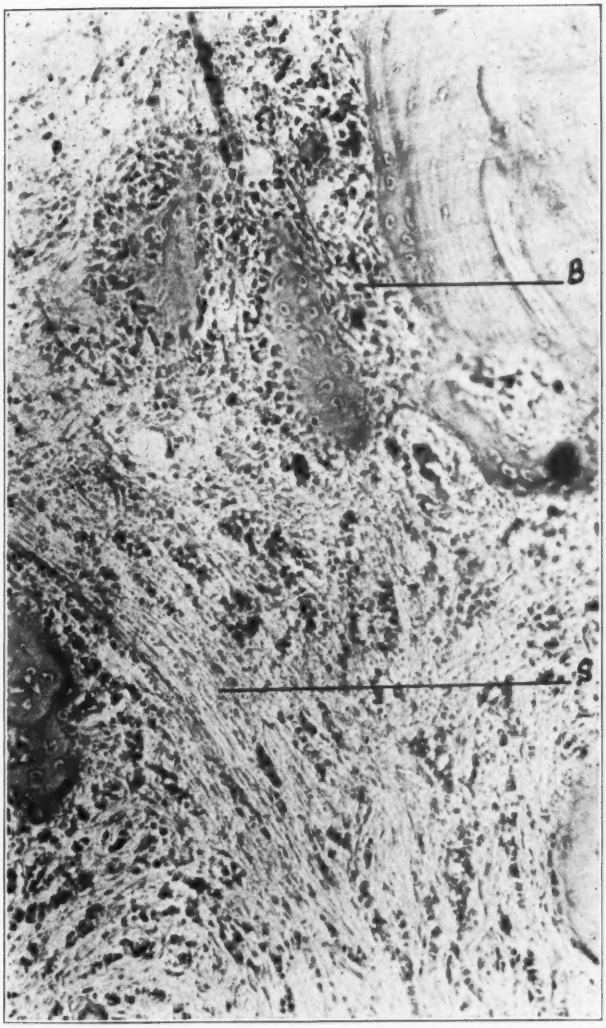

Fig. 2.—A field from the periphery of the tumor, showing at *S* the dense fibrous stroma which surrounds the small nests and cords of tumor cells. *B*, new bone formation on the borders of which many osteoblasts may be seen.

bone, was observable. Again, in these instances where the tumor cells crowded closely against the bone, no osteoblasts could be distinguished, but, in other areas, where less invasion had occurred, these cells were usually to be seen. (Figs. 2, 3, 4 and 7.) Much of this cancellated tissue, like that mentioned above, ap-

Fig. 3.—A field from deeper within the tumor in which the tumor cells predominate over the stroma and surround the bone on all sides. At B^1, there has been a new formation of cancellated bone, which is continuous with B^2, the old bone. Neither shows any resorption.

peared to consist of osteoid tissue, giving the impression that possibly calcification had been delayed. In some areas, this new, cancellated formation seemed to be following the reticulated fibrous stroma, which, especially in the absence of osteoblasts, often gave the appearance of a change taking place the exact opposite of bone formation; namely, the appearance of bone dissolution. (Fig. 7, $B.^1$) It

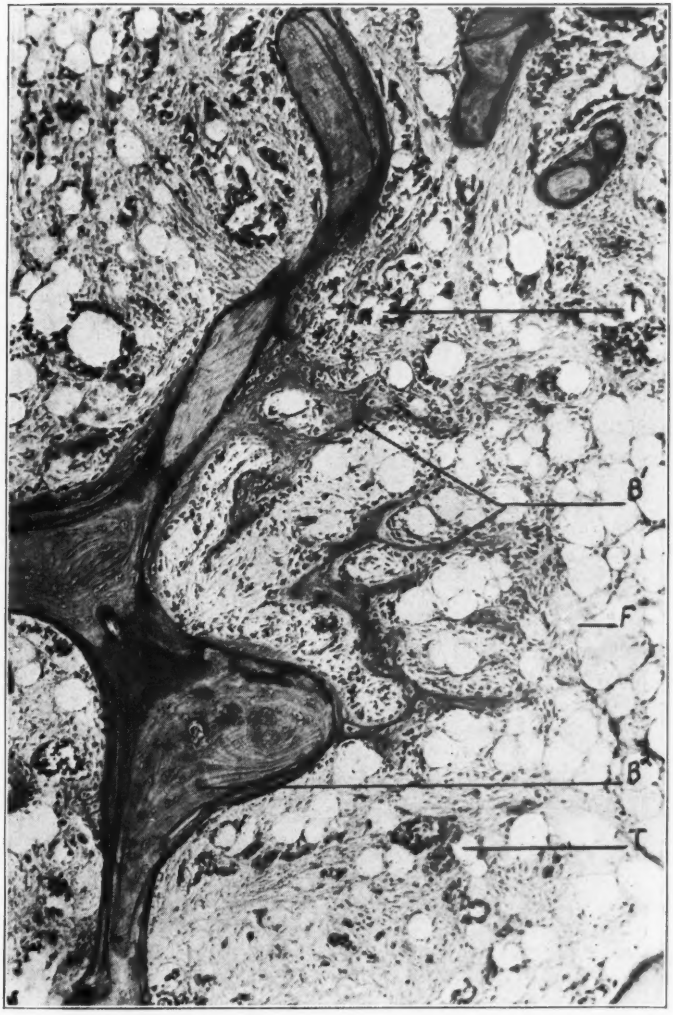

Fig. 4.—A field near the periphery of the tumor showing at B^1, a new, cancellated bone formation which is continuous with the old bone B^2. Tumor cells T surround the bone except on the side F, where the original marrow tissue persists.

seems much more likely that all of this was a formative process, especially in view of the fact that few authorities today recognize other types of bone dissolution besides lacunar resorption. Taking everything into consideration as it is presented by this material, the feeling is had that, with the complete invasion of

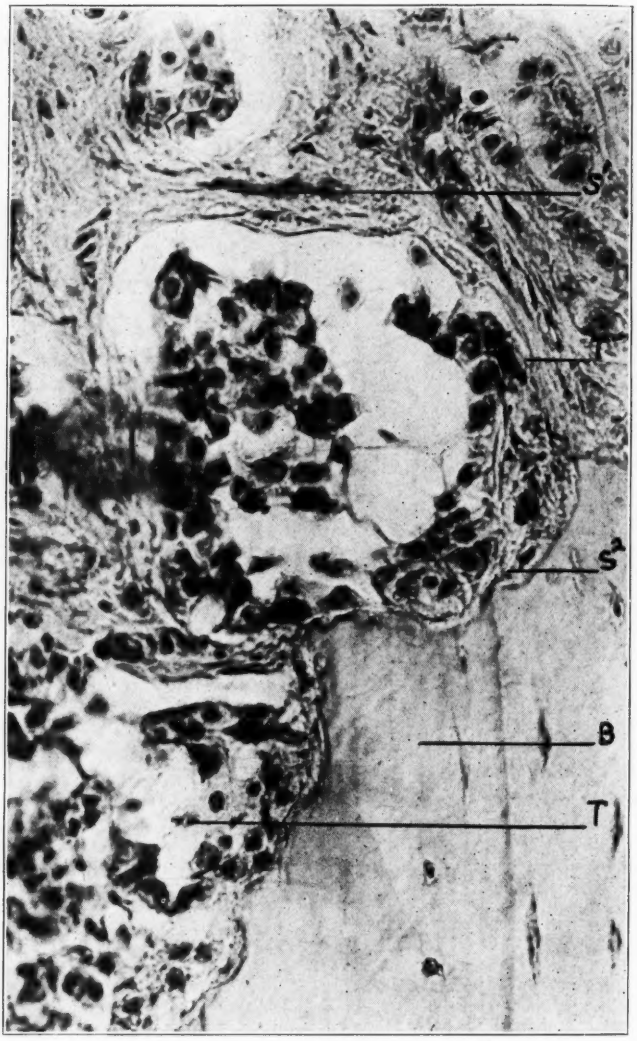

Fig. 5.—Tumor cells occupying resorption lacunae on the surface of the bone, *B*. S^1, fibrous stroma of the tumor which, at S^2, intervenes between the tumor cells *T* and the bone surface.

an area by the tumor, practically all change in bone comes to a standstill, with the exception that possibly atrophy of the bone cells will continue because of a disturbance of circulation.

The characteristic, inflammatory reac-

tion which usually accompanies the development of many tumors, was markedly noticeable. It was present almost everywhere in advance of the tumor cells. which had not been invaded by the tumor, inflammatory cells were present, sometimes in such large numbers as to entirely blot out the typical marrow tissue.

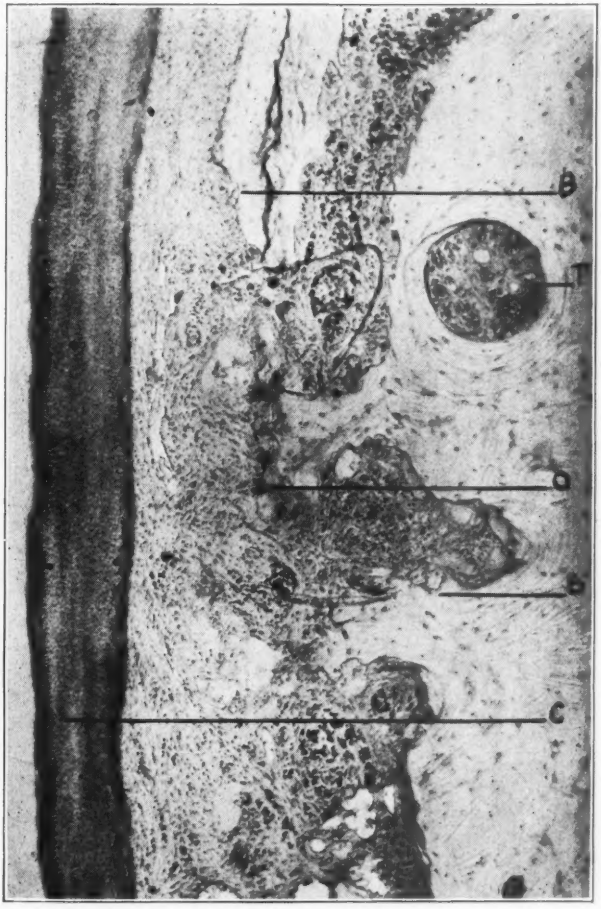

Fig. 6.—*B*, resorption lacunae occupied by fibrous tissue; *T*, a haversian canal occupied by tumor cells; *O*, osteoclasts on the peridental membrane surface of the bone. The cementum, *C*, is unchanged.

Thus, in the anterior regions and in the alveolar process above the apical area Eosinophils were extremely numerous among the many types of cells present.

Fig. 7.—*C*, cementum; R^1, resorption lacunae occupied by fibrous tissue; R^2, resorption lacunae, occupied by tumor cells; *O*, osteoclast on peridental surface of bone; B^1, new bone formation with osteoblasts absent, continuous with old bone, B^2; *S*, fibrous stroma; *P*, peridental membrane invaded by tumor cells. The cementum is unchanged.

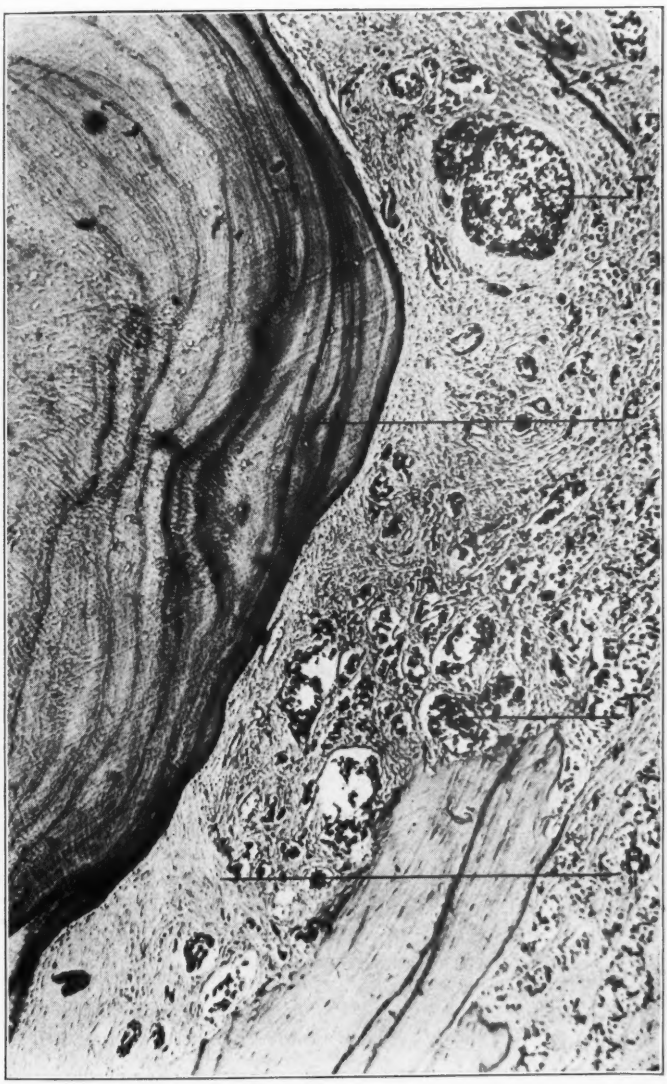

Fig. 8.—*P*, peridental membrane invaded by tumor cells, *T*, with the complete loss of bone between *T* and *T*. The cementum, *C*, is unchanged.

HOW THE GENERAL PRACTITIONER OF DENTISTRY CAN PREVENT AND CURE PYORRHEA

By BRUCE L. TAYLOR, D.D.S., Washington, D. C.

PERHAPS some of you may wonder why I come to you today to read a paper on the prevention and cure of pyorrhea alveolaris, since so much has already been written about it up to the present time; but I feel it is my duty as a member of the dental profession to do what I can to show you just how easy it is to prevent this dreaded disease and to cure it when once it has attacked the supporting structures of the teeth.

For the past ten years, my time has been devoted entirely to the treatment of pyorrhea and other diseases of the oral cavity, and I have been astounded to note the fact that 75 per cent of the patients who come to me for treatment have pyorrhea, although they have visited a dentist once or twice a year since they were 8 or 10 years old. Practicing as I do in Washington, D. C., I find that this condition does not apply only to those who were born in the District of Columbia; for, as you know, perhaps 50 per cent of the people who reside in Washington were born and reared in some other state or some other country; in fact, we have patients from all parts of the world. I ask you, can the dental profession be proud of such a record? I sometimes feel that dentistry is just a 50 per cent profession; 50 per cent for restorative work and nothing for prevention. There are just two ways in which most of the teeth are lost. One is by dental caries, the other by diseases of the supporting structures.

Since the time of Miller, whose able and painstaking research established the cause of dental caries, we have made some progress along the lines of prevention of tooth decay. G. V. Black could see far enough ahead to know that it would be from 100 to 200 years before the public, with the aid of the dental profession, could be taught how to prevent dental caries, and so brought forth the principle of "extension for prevention." There are a number of us here today who know what a hue and cry went up from dentists from all over the land in regard to the "ruthless destruction of sound tooth structure." My voice was one among them. But today we all know how sound that principle was, and we have come back to worship at his altar.

Dr. Black, as we shall see, was interested not only in the prevention of dental caries, but also in the prevention of diseases of the supporting structures of the teeth. In his book called "Special Dental Pathology," he says, in regard to diseases of the investing structures of the teeth:

> The insidiousness of this class of disease is such that not many, even dentists, have been regularly in the habit of noticing them during their early stages. A little redness here or there seems to be of no consequence, and after a time, when the case has gone too far

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for remedies to be effective, the dentist will find the disease very serious and incorrectly suppose that it is comparatively recent in its beginning. The dentist should make a careful examination of the gingivae of every patient, and if there are inflammations, they should have immediate and most painstaking treatment. No matter what may be the cause of such inflammation, it should be searched out to the limit, found and removed. In this way, I am persuaded, from past experience, that the vast majority of these cases can be prevented by removing the danger in its inception.

This work of Dr. Black's was published many years ago, and yet how few of our profession have heeded and put into practice his very able advice.

C. N. Johnson, another one of the masters of our profession, in his book entitled "Methods of Filling Teeth," gave us the same advice that Dr. Black did, and Dr. Johnson's book was published, if I remember correctly, many years before Dr. Black's. And so I might go on and quote from many others, but the fact remains that the dentist is not much concerned with methods of prevention. What he is interested in is how to make a gold inlay, take an impression, mount models on articulators (which are too numerous to mention) and extract teeth. There are almost as many good ways of doing the things I have just enumerated as there are mouth washes on the market, to prevent and cure "bleeding" and "spongy" gums.

A. B. Crane, of Washington, in discussing a paper at one of our dental society meetings, said: "Most dentists when examining the mouth see nothing but teeth and places where teeth should be replaced."

INVESTING TISSUES OF THE TEETH

If we are going to make an attempt to prevent and cure pyorrhea alveolaris, we must bear in mind that there are three distinct and separate structures which support and invest the teeth, although they are very closely related; namely, the gingiva, the pericementum or pericemental membrane and the alveolar process. Perhaps it may be well for me to give you the classification and terminology I use for the various diseases of these structures. I do not ask you to use these terms, as I worked them out for my own convenience some years ago, under the guidance of Dr. Ralph Hamilton, who was professor of pathology and bacteriology in the medical department of Georgetown University, but I believe them to be more comprehensive than some of the terms now in use.

The diseases of the gingiva are: (1) gingivitis; (2) acute gingivitis; (3) chronic gingivitis; (4) acute suppurative gingivitis; (5) chronic suppurative gingivitis; (6) hypertrophic gingivitis; (7) acute hypertrophic gingivitis; (8) chronic hypertrophic gingivitis; (9) acute suppurative hypertrophic gingivitis; (10) chronic suppurative hypertrophic gingivitis; (11) ulcerative gingivitis; (12) Vincent's gingivitis.

The diseases of the pericementum are: (1) pericementitis; (2) acute pericementitis; (3) chronic percimentitis; (4) acute suppurative pericementitis; (5) chronic suppurative pericementitis; (6) phagedenic pericementitis; (7) pericemental abscess; (8) fibroid degeneration of pericementum; (9) calcific degeneration of pericementum; (10) pericemental granuloma.

Diseases of the alveolar process are: (1) alveotitis or osteitis; (2) suppurative alveotitis; (3) acute suppurative alveotitis; (4) chronic suppurative alveotitis; (5) rarefying alveotitis; (6) condensing alveotitis; (7) alveolar atrophy; (8) alveolar abscess; (9)

acute alveolar abscess; (10) chronic alveolar abscess.

Pyorrhea alveolaris is a good term, since it means a flow of pus from the alveolus, and the terms "suppurative pericementitis, acute and chronic," "suppurative alveolitis, acute and chronic" and "pyorrhea alveolaris" are synonymous, they being practically one and the same disease. Each of the diseases of the gingiva that I have enumerated has a definite pathology which distinguishes it from the others, and we should never consider that we have a case of pyorrhea until the alveolar process has been reached by the diseased condition of the gums and a definite pocket has formed from which pus can be pressed. Then, too, we may and generally do find several of these gingival disorders associated with the pyorrhea. Do not let us call a suppurative gingivitis, pyorrhea alveolaris because it is so ridiculously easy to cure it as compared with a true case of suppurative alveolitis.

PREVENTION

If pyorrhea is to be prevented, we must be just as careful in examining the gingival tissues for the slightest signs of inflammation as we are in examining the teeth for dental caries. There must be an initial inflammation. There is, I believe, just one thing that causes pyorrhea, and that is inflammation. If we can prevent this, we can prevent pyorrhea. In my study of this disease and in clinical observation, extending over a period of thirty years, I have never seem a case that did not have a history of some inflammatory condition as its origin.

When we have an irritated and inflamed condition of the gums, the blood vessels and capillaries become dilated, the blood circulation slows down, the white blood cells or leukocytes begin to hug the walls of the blood vessels, passing through them; the blood serum passes through the blood vessels, carrying with it lime salts from the blood. Owing to the dilation of the capillaries and blood vessels, the flow of lymph is interfered with, and a condition of stasis exists. The lime salts of the blood are held in solution by carbon dioxid; but as soon as the liquid constituents of the blood pass through the blood vessel walls, carbon dioxid is given off, and the lime salts are precipitated, becoming united with dead epithelial cells, food débris and mucin, just beneath the free margin of the gum, and forming what is known as serumal calculus or subgingival calculus. This serumal calculus, which is at first soft, becomes hardened as more lime salts are deposited and acts as a further irritant to the surrounding tissues, which lowers their vitality and renders them susceptible to the action of the micro-organisms which produce infection.

Suppose something happened to this beautiful city in which we live, and it was impossible for any one to leave. Suppose the water supply was cut off and the sewers were stopped up so there would be no drainage to carry off the waste and all railroads, bus lines, etc., were shut off so we could not get food of any kind. We would all die. And then the vultures and buzzards and crows would come to eat our bodies. That is what happens to a colony of healthy tissue cells when inflammation sets in. The pathogenic bacteria are the buzzards, vultures and crows.

CAUSES OF INFLAMMATION

There are many causes of inflammation of the gums, chief among them being the presence of micro-organisms, trauma and diet deficiencies. Micro-organisms develop through fermentation of carbo-

hydrate foods lying beneath the free margins of the gums and from acids which irritate the delicate epithelial lining of the gingival crevice, producing an inflammation; and when a tissue becomes inflamed, its vitality is lowered, the pathogenic bacteria gain a foothold and infection sets in. The same condition may obtain from traumatic occlusion, only the irritation is caused by the trauma. Again, inflammation is set up; the vitality of the tissue is lowered, and it is subject to infection. Errors in diet may cause inflammation of the gingiva reflexly through the pneumogastric nerves and by circulation of poisons in the blood stream. Other agencies which may produce inflammation are overhanging edges of crowns and fillings, bridges, both fixed and removable, plates improperly placed or poor contact points, absence of contact, hot drinks, excessive smoking, improper brushing and swallowing while the lips are closed during sleep, which produces a vacuum in the mouth.

Perhaps the commonest cause of pyorrhea that we have to contend with today is the eruption of the third molars. Because these teeth rarely have room in the arch to erupt normally, they crowd the other teeth, which causes the contact points to slip. This slipping of the contacts unbalances the occlusion, and the periodontal membrane supporting the teeth is subjected to an excessive pressure, thereby becoming inflamed.

Another great cause is the neglect to replace teeth as soon as the gums have healed after extraction.

PREVENTIVE TREATMENT

The first and most important thing in the treatment for the prevention of pyorrhea or for pyorrhea already present is to lock up securely in our cabinet aconite, iodin, Talbot's solution and all the "pyorrhea cures" that we may have, and get out our instruments. It does not make much difference whether they are Hartzell's, Carr's, McCall's, Bates', Dunlop's or some other man's as long as we can use them and they will pass under the margins of the gum without causing lacerations. Then we very carefully curet the surfaces of the root or roots of the tooth we are operating on until it is perfectly smooth. Let us stick to one tooth until the surface we are curetting feels as smooth as velvet to the instrument. At first, it may take considerable force to remove the heavy deposits, and in such cases, a strong, heavy instrument should be used, the finishing being done with a thin, delicate one. A very sensitive touch is necessary so that we can feel the least roughness, for the success of the operation depends entirely on the thoroughness with which it is done. We pass on to the next tooth, and so on, until the root surfaces of every tooth have been gone over. Do not think that because there is no inflammation of the gum around the tooth, it does not need attention. A thin, sharp curet should be passed under the free margin of the gum and carried around and between the teeth. Very often, we will find very small particles of calculus that we would not have discovered otherwise. It is just these little pieces that cause trouble later on, if they are not removed.

After instrumentation has been completed, the teeth should be thoroughly polished with finely ground pumice stone. The polishers are used in the engine for all accessible surfaces, and this operation is followed by the use of orange wood points in a hand porte polisher for the interproximal surfaces. We finish by polishing between the teeth with dental tape. Overhanging edges of fillings and crowns should be finished off

to proper contour, and if this cannot be done so as to remove the source of irritation, they should be removed and replaced by others that have proper contour and fit the necks of the teeth under the gingiva without causing irritation. Let us look to the occlusion, and if any tooth or teeth are receiving too much stress during the process of mastication, the stress is relieved by grinding until the occlusion is properly balanced. All missing teeth are replaced with artificial ones, to hold the natural teeth in position and increase or restore masticatory efficiency.

Exercise is necessary to keep the periodontium in a healthy condition. We should recommend a diet of coarse foods, such as spinach, kale, celery, lettuce, asparagus, raw cabbage, water cress, whole wheat, graham, rye or corn bread and toast, and fruit of all kinds, especially fresh fruit, which should be eaten at the end of the meal. These foods, besides giving exercise to the supporting structures, polish the teeth, massage the gums and, on account of their fibrous content, help to prevent constipation. We should caution our patients not to eat too much and to drink eight glasses of water every day. Many people suffering from pyorrhea eat to excess. Meats, sweets and pastries are to be eaten sparingly. That "we are digging our graves with our teeth" is the truth.

PYORRHEA

Pyorrhea alveolaris can be cured. No matter how skeptical you may be, I want you to carry this one fact home with you. It is not the baffling, mysterious disease that we have been led to believe it to be. The reason so many of us have failed to cure it is because we have depended mostly on medicaments. If you went to a physician with a splinter or some other foreign substance in your finger, and all he did was wash off the part and put iodin or some other medicine on it and tell you to come back in two or three days for another treatment, you would not have a very good opinion of him, I am sure. Nor would you think very much of a doctor who treated a case of acute appendicitis by giving the patient morphin. He might make the patient comfortable by the use of it, but death would surely follow. Aren't we doing just about the same thing when we try to cure a case of pyorrhea with some drug; when we know or should know that there are deposits of serumal calculus in the pocket and the remains of a dead pericemental membrane attached to the surface of the root? How could we expect to get results from such treatment? What we must do is to take instruments of proper size and shape and with them go to the very bottom of the pocket, curetting it until the surface of the root is smooth. Let the pocket fill with a blood clot, which should not be removed, spray out the mouth, and the next day, if we have done our work well, there will be no pus present.

There are three stages of pyorrhea. In the first stage, the gingival third of the alveolar process is involved; in the second stage, the middle third of the alveolar process, and in the third stage, the apical third of the alveolar process. It is curable in the first and second stages and sometimes in the third stage. It is in this stage that the apical third of the process has been reached by the diseased condition on only one surface of the root. It is not always necessary to extract teeth when the disease has reached the bifurcation of the roots. By careful instrumentation, such teeth can be saved.

It is always well before treatment of a case of pyorrhea is begun to have a full roentgen-ray examination of the

mouth. But we cannot be sure of the depth of the pockets from these pictures. The angles at which they are taken in order to show the apices of the roots nearly always augment the depth of the pockets.

The mouth should be carefully examined with blunt pointed explorers to ascertain the depth of each pocket and the findings charted on an examination blank or the record card of the case. We must avoid the use of drugs and use our instruments. We must cure our cases by thorough and painstaking instrumentation. Only this will give us results which will last.

In treating loose teeth, we should curet first and then grind for the correction of the occlusion. The fact that a tooth is loose is no sign that it should be extracted. We must treat it and grind the occlusal surface until it does not touch the opposing tooth; give it surgical rest, and it will become firm and useful again.

After each tooth in the mouth has been thoroughly curetted and the flow of pus is stopped, the teeth should be polished. The patient should return for examination and prophylaxis at least once a month for three, four or six months according to the severity of the case. When we are sure that there is no inflammation or pus present and the occlusion has been perfectly balanced, the patient should be asked to return for prophylaxis once every three months.

In my office, these prophylactic treatments are given by the dental hygienist, and the patient is sent back to me once a year or once every eighteen months for treatment. By this procedure, a recurrence of the disease can absolutely be prevented.

The home care of the mouth by the patient is of the greatest importance. He should be instructed at the chair how to brush the teeth, how to use the dental tape and how to massage the gums. I recommend physiologic sodium chlorid solution as a mouth wash and for massage of the gums. This can be made from sodium chlorid tablets, which can be purchased at any drug store, or by dissolving half a teaspoonful of table salt in a glass of water. It gives the best results of all mouth washes I have ever used. The patient should brush the teeth first with any good tooth powder or paste (Charters' method); then use the dental tape to remove any particles of food not reached by brushing, and finish by massaging the gums, buccally, labially and lingually with the finger, which should be wet often by dipping it in physiologic sodium chlorid solution. He should then rinse the mouth with the salt water until the whole glassful has been used. Here, I take issue with all those of our profession who advocate brushing the teeth by placing the brush well up on the gums and bringing it down toward the crowns of the teeth. Some claim this method will prevent recession of the gums. It will not. But it will produce gingivitis. If your hand was injured and you went to a masseur for treatment and he began massaging at your shoulder or elbow, working down to the hand, you would be sure he did not know his business. He would be forcing the veinous blood back into the sore hand. That is just what happens when you brush from the gums downward. The first pressure against the gums with the brush should be with the sides of the bristles against the interdental gum tissue forcing the blood back into the circulation carrying with it the waste products which are to be eliminated. With the brush in this position, the handle is turned slightly so that the ends of the bristles slip into the inter-

dental spaces, then, by a vibratory motion, the bristles are worked well in between the teeth. When the pressure is released by each vibratory movement, fresh arterial blood flows into the tissue bringing nutrition to the half starved cells.

I do not sanction the use of drugs for the prevention or cure of pyorrhea, nor do I use them; but I must admit that I have lost many patients because I did not inject some kind of medicine "into the gums," and many have not paid their bills because, as they said, "all you did was scrape my teeth." So you see the cure of some cases necessitates the use of psychology. If we must use a drug, perhaps the best one that we can find in the pharmacopeia is a 2 per cent alcoholic solution of iodin, which is both stimulating and germicidal. A glass syringe with a blunt point, either gold or platinum, is used to inject a drop at the bottom of each pocket. This treatment is not used until all the flow of pus has ceased, else we may obscure the cause and have a recurrence of the disease later on.

CONCLUSION

The medical profession has made great progress along the lines of prevention in the past ten or fifteen years. Many diseases which were common years ago are of rare occurrence now, and the percentage of a great many diseases has been reduced greatly. As I have said before, we have but two diseases to contend with. Let us through the practice of prevention reduce the percentage of these diseases until, in the next twenty-five years, it will be a rare thing to see a man or woman between the ages of 18 and 60 years wearing full upper and lower dentures. Instead of our colleges turning out each year a crop of prosthodontists, exodontists, radiodontists, oral surgeons and diagnosticians, let us have men skilled in the art of preventive dentistry, men who can and will save teeth.

DISCUSSION

Sidney Sorrin, New York City: Great enthusiasm is observed at all classes and meetings where the problem of periodontal disease is discussed. The recent works of Box, Stillman, McCall, Gottlieb and others in the profession have not only aided in solving various problems in periodontal disease, but have also lighted the path toward the prevention of dental disease. Preventive dentistry like preventive medicine is gaining impetus daily and the time is not far distant when colleges all over the country will stress this important subject. I was interested in the classification presented by Dr. Taylor, but I disagree slightly with his definition of pyorrhea as it relates to periodontal disease. Pyorrhea does not necessarily mean that pus must flow from the alveolus. When it has gone to that stage, it is well advanced. Pyorrhea means that the gingivae or other supporting tissues have become affected. The name "pyorrhea" has long been unsatisfactory to the dental profession, in spite of its common usage. The name itself means a flow of pus, and pus is an indication of an advanced stage of disease. The gingival tissues may be diseased for a long time, perhaps years, before actual pus formation can be detected. These earlier stages cannot be properly termed pyorrhea, yet they represent a real state of disease. Because of this fact, and because they will inevitably lead to pyorrhea unless treated, the early stages of periodontal diseases demand careful attention. This brings up the question of prevention, a most important consideration in dentistry today. To prevent disease, it is necessary to recognize tissues in health and then note deviations from the normal. For example, the marginal gingivae in health are of firm texture and are pink, and completely fill the interdental space. They present also a thin knife-like edge which has a definite semilunar outline. Dr. Box, of Toronto, has outlined some diagnostic signs of periodontal disease, among which are: (1) traumatic crescents; (2) congestion of marginal gingivae; (3) recession of marginal gingival line; (4) McCall's festoons; (5) Stillman's clefts; (6) shortening of the crest of the septal gingivae;

(7) absence of stippling; (8) increased depth of gingival crevice; (9) epithelial nodules; (10) mobility of varying degrees; (11) various changes in the alveolar bone; (12) gingivitis; (13) linear depressions. Conditions that tend to produce disease can be ascertained if the proper diagnostic chart is used. Such a chart is employed in the N. Y. U. College of Dentistry and has been of great aid in tabulating periodontal conditions. All systemic and local conditions are recorded, guiding us as to whether such local conditions as traumatic occlusion, marginal irritation, defects in contact points, food impaction, the presence of faulty bridgework, or margins of fillings, crowns or bands, toothbrush trauma, calculus or local acidity, have been the etiologic factors; or whether diet, systemic disease, disturbed metabolism, gland disturbances, etc., have been instrumental in causing disease. It will also indicate whether the conditions observed are recession, erosion, gingivitis, alveoloclasia, pericementoclasis or periodontal abscess. In short, the proper diagnostic chart helps one discover all these factors by the thoroughness of attention paid to details. Diagnosis depends for its success not only on the recognition of subjective and objective symptoms but also on a knowledge of mechanical relationships and roentgenographic diagnosis. Occlusion has been discussed so often that, in passing, I should like to say that grinding of the occlusal surfaces is a difficult process, and it can be accomplished only after a thorough study of the subject. Study models should be made, for much harm may result from inaccurate grinding. The roentgen ray, with an accurate clinical history, makes an ideal means for determining correct diagnosis. Here, again, we must have a conception of the normal. Around the normal tooth, under the roentgen ray, we have a very thin dark line and beyond this is a white line called the lamina dura, a layer of relatively dense bone which constitutes the inner wall of the alveolus. Beyond the lamina dura, the bone is of more cancellous structure. Among the many periodontal conditions revealed are (1) early alveolar absorption; (2) pericemental irritation; (3) rarefaction; (4) bone condensation; (5) resorption of roots, and (6) rarefying pericementitis fibrosa. Many failures have resulted from either poor roentgenograms or inaccurate interpretation. We determine the depth of a pocket by placing guttapercha points in it and then taking a roentgenogram. Prevention of peridontal disease can be attained if particular attention is paid to the treatment of lesions when they appear. This makes it necessary to acquire a knowledge of the fundamental principles involved. An analogy may be drawn between a camera supported on a tripod and periodontal disease. We know that in order to obtain excellent pictures, it is necessary first to balance the camera properly, and this depends on the stability of the tripod. Each leg is adjusted to give the camera support. The treatment of periodontal disease may be compared to the camera in its dependence on a tripod of three conditions: (1) the removal of all conditions which cause lowered resistance; (2) an understanding and application of the principles of scientific instrumentation, and (3) building up of tissue resistance. Without the combined influence of these conditions, the treatment, in the long run, is doomed to failure. The building up of tissue resistance may be accomplished by the proper application of the toothbrush. The removal of deposits, etc., is made possible by the scientific use of instruments, and the eradication of the etiologic factors may be accomplished by careful and painstaking efforts on the part of the operator. I was happy to learn that Dr. Taylor believes that traumatic occlusion is a vital etiologic factor, as our experiences in clinic work are continually pointing in that direction. Only recently has the profession taken up the study of traumatic occlusion as one of the most important considerations in all dental restorations. Incidentally, many complaints arising after insertion of fillings, and reports of pain on ridges after wearing of artificial dentures have been traced to lack of occlusal equilibration. During the last five years, more than 4,000 patients have been treated in our periodontia clinic, and close observation indicates that traumatic occlusion plays a most important part in the production of periodontal disease. Figuratively speaking, this etiologic factor has been found dominant in 85 per cent of the cases treated in our clinic. Nonreplacement of lost teeth, eruption of third molars, high restorations, saddles resting against the gingival tissue surrounding the teeth, clasps which irritate the gingival margin have all caused periodontal disturbance. One of the outstanding conditions responsible for failure in treatment is lack of confidence in one's ability to

secure results. Only after one has learned the fundamentals and practiced them can he become convinced that the disease is curable. Success in treatment requires much patience and particular attention to all details. In the treatment of more advanced cases, care should be taken not to attempt the impossible. Some dentists are satisfied when the pus flow ceases and the gingival tissue is restored to normal. Very often, a quick result is observed after the use of medication and removal of deposits, but further observation reveals that the destructive process continues. I am glad to learn that Dr. Taylor does not advocate medication in the treatment of periodontal disease. I have tried it where all else has failed and I do not know of any case in which it has been of any particular help; and this includes the use of ultraviolet rays and vaccines. Other agencies will be employed which might assist in treatment, and new methods may be used in the future to cure periodontal disease, but they will not prove successful unless the dentist understands the primary principles upon which the treatment of periodontia is based. These include: (1) a study of the tissues involved; (2) removal of all etiologic factors, especially traumatic occlusion; (3) the scientific method of instrumentation; (4) instruction in diet and the proper method of gingival stimulation by the use of the toothbrush. We have been fortunate to learn how dietary insufficiencies, disbalance and lack of vitamins will affect the metabolism of a body and cause serious systemic disease. The effects are often observed in the structure and development of the dental apparatus. I should like to make a plea to those present that more time be spent in teaching the proper diet to children and mothers. We have had the opportunity during the past few years, to examine the mouths of a number of pregnant women, and close observation indicates that these patients lack the knowledge of proper diet and care during this period. In many instances, physicians have either failed to observe the effect of pregnancy on the teeth and supporting structures or have not given the patients proper instruction as to diet. The loss of bone and tooth structure during this period has been appalling. The development of pyorrheic conditions in pregnant women is quite marked where there is malnutrition. The disbalance of calcium and phosphorus causes a profound change in the structure of the bone supporting the teeth. When other factors such as occlusal trauma are present, the destructive process is so rapid that changes which under other circumstances take years to develop, at this time take place in a period of a few months. The body seeks its reserve, and not only does the entire body suffer, but the teeth and the supporting structures particularly. Especially is this so during the period from the seventh to the ninth month, when the expectant mother supplies the greatest portion of the required mineral matter for the fetus. The fetus at this stage grows considerably, and calcium salts which are circulating in the blood are apparently being drawn on to provide for the development of the child. It is known that the formation of the teeth begins early in the fetus. Prenatal diet is important, and if properly arranged, can have far-reaching effects on the development of the dental structure of the fetus. Even during lactation, care must be exercised, because deficiencies in diet, even in breast-fed children, may cause rickets. The mother will be enabled to save her teeth and the unborn child will have a good start in life as regards its teeth. As soon after birth as possible, the child should be given the proper well-balanced and vitamin-containing foods, in order that good health can be maintained. The importance of prenatal influence cannot be too strongly emphasized, as the future health of the child may depend on the care given it during this time. Many speak of diet and nutrition, yet few direct the information to the proper channels. Teach the knowledge of nutrition to the mother and children, and much dental disease will be prevented. This is the age of prevention. What greater satisfaction can there be than to realize that it is possible to prevent disease, rather than treat advanced cases?

W. A. Jaquette, Swarthmore, Del.: We are indebted to the man who tells us our faults in a kindly way, but we are more indebted to him when he comes to us with encouragement. The dental profession, as you have heard tonight, has not appreciated its responsibility in this field to the same extent that it has in the field of care of the teeth. If every surgeon or internist should come to us with a new terminology, we would spend our energies in trying to follow him rather than his subject. The American Academy of Periodontology has a special com-

mittee on nomenclature. The American Dental Association has its Committee on Nomenclature, and we have our own Dr. Anthony with his dictionary. The term "pyorrhea" is the one most used, but that it is bad is illustrated by the following: A patient goes to her dentist and in awed tone she says, "Doctor, have I pyorrhea?" He takes a hurried glance; there is no welling up of pus around the teeth, so he says, "No." She gives a sigh of relief and then she is assured that she can go on as she has been doing. Someone has made the statement that pyorrhea is a pathologic condition of which the patient becomes conscious ten, fifteen or twenty years after its incipiency. The term "periodontoclasia" is divided as follows: Greek, peri, around; odous, tooth, and klassis, breaking down; the breaking down of the tissues surrounding the root of the tooth. At the very beginning of the breaking-down, we should be most interested, and then we will not see this welling-up of pus. We are somewhat in the position the medical profession was years ago: Consumption, as then called, would of course, terminate fatally. We know that tuberculosis is a definitely controllable condition, and that many patients are restored to health. If we see pyorrhea with a great flow of pus about the gingiva, we have certainly approached the hopeless state. I quote: "There is just one thing that causes pyorrhea, and that is inflammation." Harold Keith Box, of Toronto, who has been mentioned as one of the really serious students in this field, says in his book: "Treatment of the Periodontal Pocket": "In the complex periodontitis, profound structural changes precede the appearance of the gingivitis. These are found in the deeper tissues where a chronic and progressive lesion of the pericementum has resulted in a change of its normal arrangement and a rarefaction of the alveolar bone. This underlying lesion termed 'rarefying pericementitis fibrosa' is for a time, at least, the dominating one." Again, Dr. Taylor has described three stages of pyorrhea: Involvement of (1) the gingival third of the alveolar process; (2) the middle third, and (3) the apical third. Again, I quote from Box: "Harmful sequelae of rarefying pericementitis fibrosa: With the formation of the new tissue in the pericementum and through increase in size of its various perivascular nodules, many principal fibers are severed, thus altering the functional conditions of the pericementum as a whole; at the same time, the alveolar bone associated with these fibers loses the functional stimuli necessary for its normal building and repair. By absorption of bone through encroachment of the new tissue upon the alveolar surface, together with the loss of bone through atrophic changes, the inner wall of the alveolus is removed. Thus, there is permitted an increased mobility of the tooth in its alveolus beyond the normal. This mobility is a factor which accelerates the rate of progression of the disease processes, including infection if established." Again, Dr. Taylor has spoken of the mouth wash. He has spoken of the normal physiologic sodium solution, which he prefers. I believe Hermann Prinz's formula is better. It is a normal physiologic sodium solution made alkaline. You are all familiar with his formula: phenolphthalein, 1 grain; saccharin, 12 grains; menthol, 15 grains; lime (calcium oxid), 150 grains; "Shaker" salt, 1 pound. We know that we are constantly flooded with misinformation as to the advantages of dentifrices. This practice has become so widespread that the American Medical Association published an editorial on the subject recently. I quote: "The main agreement between workers in what appears at first sight to be wholly unrelated systems is not without some significance, for the claims made for the many dentifrices and mouth washes now on the market. Dentifrices of both acid and alkaline nature are sold with the claims that they will correct all sorts of supposed conditions in the mouth. Many of the alkaline dentifrices, presumably designed to correct mouth acidity (which in a sense is the normal condition), are especially blatant in their announcements. If an abnormal acid or alkaline condition is present in the mouth, there is probably an underlying constitutional cause which should have the expert attention of physician and dentist. Clark and Carter describe the tendency of the saliva to return to its normal state in the following words: 'Accepting an average hydrogen ion content of 6.6 (for normal saliva), it is evident that saliva is a well buffered mixture and would be able to neutralize large amounts of hydrogen or hydroxyl ions without showing appreciable change in the p_H value.' Sooner or later, manufacturers of dentifrices will have to heed the results of scientific investigation. The chief purpose of a dentifrice is to clean the teeth, or, more practically, to establish a healthy habit. The balance of

evidence is against the view that dentifrices can be used for so-called mouth correction." Dr. Taylor has emphasized repeatedly throughout his paper that he is opposed to medication. To a great extent, I think most workers in this field are in accord. There is something that was called to the attention of a group this afternoon by Dr. Sorrin. I should like to quote from a book of which he is one of the editors, "The Practice of Periodontia" (Sorrin and Miller): "One of the most serious drawbacks in the treatment of periodontal pockets in previous times has been the difficulty and also the uncertainty of closure after treatment, with consequent possibilities of reinfection, and this even with the most diligent and conscientious efforts of the patient and dentist. In determining the reason for failure in this respect, we must first glance briefly at the histopathology of the pocket and its relation to other periodontal tissues. Therein we can see the light. As the pocket deepens, the epithelium dips down to cover up the denuded surface. This epithelium will extend practically to the bottom of the pocket in all chronic cases of periodontoclasia. However, we observe that bone and epithelium never come in contact, always being separated by a layer of fibrous connective tissue." He goes on to describe the use of the sodium sulphid formula which McCall and Stillman have worked on, as he has quoted. Dr. Taylor emphasizes three points: early diagnosis, prompt treatment and home care. We may assure our patients that while they need a dentist for preliminary treatment, they control the greater portion of the work in establishing a cure. The dentist does his part, but more depends on the care by the patient. Stillman said that, some years ago, much of his income came from the return of patients for treatment. He stated that with proper instructions as to home care, he finds that that is not now the case, that they go away and stay in a good condition for a long time. D. D. Smith, as you know, required his patients to come in once a month. I think this is most unfortunate and should be discouraged. The result is this: The patient for a couple of weeks after having visited the dentist is determined to do his part, and then he says, "I am going in a few days to see Dr. Smith," and he lets down. If we, on the other hand, put our patient on his own responsibility and assure him the result depends on his care, more will be accomplished.

Dr. Taylor (closing): I purposely made this paper as free from scientific terms as was possible. I do not wish to befog the dental profession with the pathology of all these conditions. If you will do the things that I have recommended, it makes no difference what sort of a condition, pathologic or histologic, you may have, you will get rid of the inflammation and cure the disease. Systemic conditions are so many and so varied, it is unnecessary to go into them at this time. An entire paper could be written on systemic conditions or diseases which may produce these gingival irritations. What I wish you to do is to say to yourselves: "Inflammation is the cause of pyorrhea." There are dozens of things that may cause inflammation, but if you can get rid of the inflammation, you can eliminate the pyorrhea. Traumatic occlusion is a potent factor in pyorrhea and the trauma must be relieved. As regards massage of the gums, Dr. Sorrin and many others recommend the use of the toothbrush. I have tried it, and I have come to the conclusion that there is nothing better than the finger when it comes to massaging the gums. Most of the brushes are too stiff. In my own mouth, I have tried them for three months at a time, and they absolutely will take off the mucous membrane. Some people have tough skin and a tough mucous membrane; others, a thin skin and a delicate mucous membrane. We can't treat all patients alike. I recommend that they do not get the ends of the bristles of the brush on the gum. When it comes to massage of the gums, I want my patient to dip his finger in a salt solution and rub it back and forth, working from the gingival margins upward. That should be done after the brushing. The last thing that is done is rinsing with salt and water. I am in accord with Dr. Sorrin when he says that the ultraviolet ray is of no use in the treatment of pyorrhea. It cost me over $780 to learn that lesson. I found that it was simply taking my time and my patients' time. I do not believe in charging a patient for something when you are not giving him results. Diet is a very important factor, but I haven't time to go into it. Keep your patients on coarse foods which will give exercise to the teeth and tissues of the mouth. As I have said before, we all eat too much. You will find that nine-tenths of the people who suffer from pyorrhea are heavy eaters. If you can get them to cut down to about half of what

they usually eat, you will get better results. Dr. Jaquette speaks of the nomenclature. I have differed from the American Academy of Periodontia because they do not classify these diseases according to the structures that are affected. I spent fifteen years as professor of dental histology and pathology at Georgetown University, and we had with our medical school Ralph Hamilton, who was an excellent pathologist. I spent many hours with him, and we studied these disease conditions a great deal and the nomenclature I have used met with his approval. "Pyorrhea" means a flowing of pus; but if the pus is only coming from gingival tissue, you may say "pyorrheic gingivitis." I prefer the term "suppurative gingivitis" because the condition begins at the gingival margin. The term "pyorrhea alveolaris" is acceptable. When I say that, my patient knows, and everyone else should know, that the alveolar process is beginning to be absorbed or rarefied. Dr. Box has done much in the laboratory in his investigations of pyorrhea; but as I have told you, it does not make so much difference what the pathologic condition is. Leave that to Dr. Sorrin and Dr. Jaquette and myself and a few of the others of us that are interested in those things. I wish to tell you something that you can do, and I do not care whether you know anything about the pathology or the histology of the disease. If you will follow the treatment that I have outlined, you can do just as good work as I can do. There is not a man here who will not spend from a half-hour to an hour in the preparation of a tooth for a crown or an inlay. If you take from a half-hour to an hour to scale a tooth thoroughly and to correct its occlusion and save the natural tooth, isn't it worth just as much as the time you have taken to prepare a cavity and a wax model for an inlay? You are saving the tooth, and that is what we are here for. When you make an examination of the mouth, look for every little point of inflammation no matter where it may be, and if there is an inflamed area, there is a cause for that inflammation. Seek it out and eliminate it. Dr. Jaquette referred to the time of the patient's return for treatment. I never see any of my patients for at least a year, sometimes not for a year and a half or two years after I have completed the treatment. They are under the care of my hygienist once every three months during this time. Recently, I had three patients come into my office. One of them was treated three years ago, another five and another four. They had only had their teeth cleaned by their private dentists and no pyorrhea had developed. They had severe cases when they came to me. We cannot clean the teeth or give a prophylactic treatment in fifteen minutes, in thirty minutes and hardly in an hour. I consider myself a rather rapid operator, but with a patient whose mouth is in the finest kind of condition, for me to take fine curets and go beneath the gum margin, around every tooth in the mouth and see that there is no roughness there and thoroughly polish those teeth takes from half an hour to an hour, always. We know that we are not spending the time that should be spent in the cleaning of the teeth. Some day, one of the things that will be required on our state boards is for a man to demonstrate a thorough prophylaxis. When we do that, it will be worth more than the gold fillings, crowns and bridgework that we are requiring today. There is just one more thing I wish to say to you. Sixty-three years ago, the Lebanon Valley Dental Society, the mother society of the Pennsylvania State Dental Society, was formed at Reading, and its first subject for discussion was "Pyorrhea Alveolaris." C. R. Scholl, a son of W. H. Scholl, who was a charter member of the Lebanon Valley Dental Society, gave me this information this evening.

PHOTOMICROGRAPHIC MOVING PICTURE USING LIVING ANIMALS: CHANGES IN BLOOD CELLS FROM LOCAL ANESTHETIC, BLOOD CELLS IN CIRCULATION, AND HEART IN ACTION, WITH ENTIRE CIRCULATORY SYSTEM OF EMBRYO CHICK

By IRA G. NICHOLS, D.D.S., Champaign, Ill.

AFTER the first postgraduate course given in this country on block anesthesia was completed, it was seen that the field was open to the study of perfecting the correct technic in the preparation of a local anesthetic. There were many who became discouraged in using it, owing to the excruciating pain following an injection of either a hypotonic or a hypertonic solution. On the investigation of the action of the above-mentioned solutions on blood cells and later experimentation on living animals, showing the changes in the nerve and muscle-tissue cells, it was proved that there was great destruction from either a hypotonic or a hypertonic solution but greater from the latter, which caused the muscle fibers and cells to contract, leaving a cloudy condition in the tissues and affecting the nerve trunk, which showed a proliferation of the syncytial cells of the sheath of Schwann and increased intraneural connective tissue.

The postoperative pain from an incorrectly prepared anesthetic solution that lasted for hours, days and occasionally a few weeks was due to use of the hypertonic solution, which broke down the blood cells by crenation, contracted the muscle tissue and caused a round-cell infiltration into the connective tissue of the nerve trunks. A concentrated solution will cause sloughing of tissue. It was found that the hypotonic solution caused the blood cells to distend (laking, hemolysis), and some to burst, this depending on the amount of sodium, calcium and potassium chlorids lacking, particularly sodium chlorid. The muscle fibers and cells become greatly distended and swollen, and the tissue is edematous owing to excessive absorption. The nerve tissue shows swollen myelin. As an example, a solution (0.7 per cent) will cause the peripheral nerve tissue to distend to about five times its normal size. The postoperative pain from a hypotonic solution is of short duration.[1]

It has always been my desire to further this work showing the effect on the entire circulatory system especially when a large quantity of a solution has been injected. Before mentioning the experiments, it might be well to go into the study of the anesthetics, the solutions and the blood. Many substances were tried to alleviate pain, but none were found

*Read before the Section on Oral Surgery, Exodontia and Anesthesia at the Seventy-First Annual Session of the American Dental Association, Washington, D. C., Oct. 8, 1929.

1. Nichols, I. G., in Smith, A. E.: Block Anesthesia and Allied Subjects, Chap. XIX, 1920.

satisfactory until cocain was introduced, in 1884, by Kollar. It was found by investigators that the injection of a solution of sterile distilled water containing cocain and epinephrin produced postoperative pain because it was not isotonic.[2]

Chemically, a local anesthetic vehicle of the same specific gravity and the same freezing point as the tissue fluids, when injected slowly, does not cause pain. An isotonic fresh Ringer's solution is an example. The vehicle possessing a greater or less osmotic tension when injected into the delicate tissues causes a break in the osmotic balance which produces changes in the tissue cells.

By the use of an isotonic fresh Ringer solution as a vehicle for the local anesthetic drugs, the tissues are not injured.

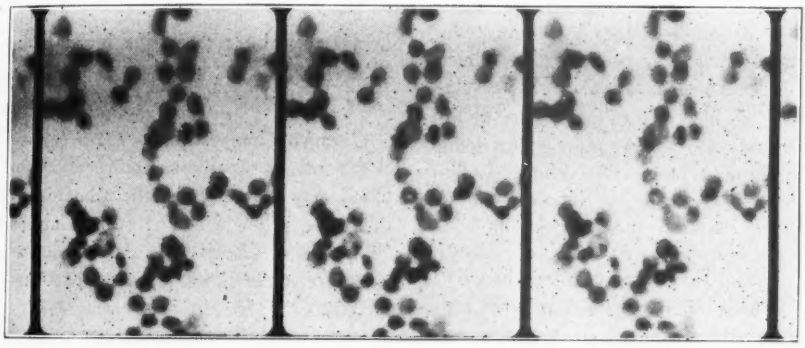

Fig. 1.—Photomicrographic moving picture made from still slide of normal blood cells.

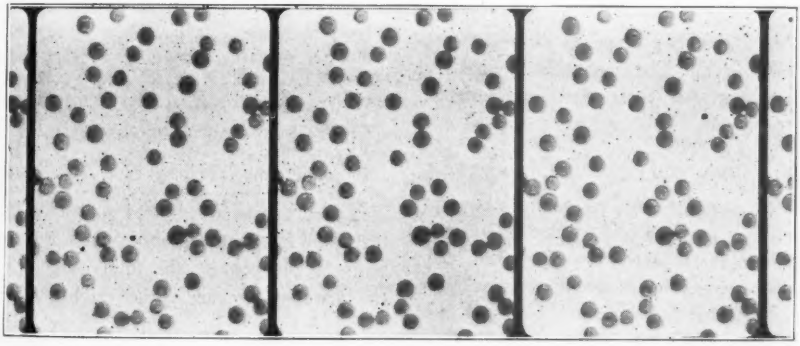

Fig. 2.—Photomicrographic moving picture of normal living red corpuscles in action that were subjected to an isotonic solution. Comparison of a certain cell in each frame shows that their position has changed.

2. Nichols, I. G.: Action of Hypotonic, Isotonic and Hypertonic Solutions Upon the Blood, Muscle and Nerve Tissue Cells of Living Animals, J. A. D. A., 9:145 (Feb.) 1922.

The three chlorids, sodium, calcium and potassium, make a true physiologic solution and have their specific functions; therefore, it is evident that Ringer's solution makes an ideal vehicle for the local anesthetic and vasoconstricting agent. A saline solution contains only sodium chlorid; whereas, Ringer's solution contains, in addition to sodium chlorid, calcium and potassium, which make a true physiologic saline solution.

THE BLOOD—GENERAL CONSIDERATIONS

"The blood is an important fluid of the body, as it bears a more or less definite and direct relation to all other body fluids and tissues. It is the intermediate substance between the nutritive materials taken into the body through the digestive tract and elaborated into pabulum by it, and body cells, to which it gives nutriment and from which it carries away effete and waste materials.

"We must, therefore, have a working knowledge of the normal physiology and histology of the blood in order to comprehend departures from the normal and to appreciate their pathologic significance."

PHYSICAL AND CHEMICAL PROPERTIES

Appearance of Fresh Blood. — The exuding drop of blood shows a number of properties even to the naked eye.[1] Microscopically, it reveals a great number of cellular elements, colored and colorless disks.

The red cells appear as nonnucleated biconcave disks, measuring on the average 7 μ in diameter. Viewed singly through the microscope by transmitted light, they are of a pale yellowish hue. The colorless cells or white corpuscles are, as a rule, somewhat larger than the red cells, and present either mononucleated or polynucleated protoplasm.

Color.—The color of normal blood is due to the presence of an albuminous substance in the corpuscles termed hemoglobin.[2] In the arterial blood, it is in combination with oxygen, and is here termed oxyhemoglobin. In the venous blood, a mixture of both hemoglobin and oxyhemoglobin occurs. With a preponderance of oxyhemoglobin, the blood tends to a scarlet hue; when the hemoglobin predominates, the blood is of a bluish color.

Chemical Composition of the Blood.— A general idea of the composition of the blood may be had from the accompanying table, which is taken from Simon's "Physiologic Chemistry." The calculations are made for a thousand parts by weight.

COMPOSITION OF BLOOD

	Parts
Corpuscles	480.00
Water	276.90
Oxyhemoglobin	193.90
Stroma, including salts	9.20
Plasma	520.00
Water	477.37
Albumins	35.88
Extractives	2.39
Inorganic salts	4.36

The predominating solid substance in the blood is oxyhemoglobin, which represents 10 per cent of the total weight of the blood, 40 per cent of the weight of the corpuscles, and 65 per cent of all organic matter present. The mineral constituents comprise sodium, potassium, calcium, magnesium and iron.

Osmotic Properties of the Blood.— The red cells will be found to dissolve promptly when a drop of blood is placed in distilled water, but when placed in an isotonic Ringer's solution, the red cells retain their normal size; i. e., when two

solutions pass through the membrane until they are of equal density, or the quantity of salts in each is equal. The force producing this interchange is termed "osmotic tension," and the two liquids containing an equal quantity of the salts are termed "isotonic." Fluids containing a greater or lesser quantity of diffusible salts are termed "hypertonic" or "hypotonic," and possess the faculty of absorbing or giving up water, in accordance with the law of osmosis. The presence of Ringer's solution prevents either swelling or shrinking of the blood and tissue cells.

ISOTONIC SOLUTION

An isotonic anesthetic vehicle must be composed of such chemical constituents in their proper proportions as are found in the blood, muscle and nerve tissue cells in order to correspond to the physiologic laws and functions of the living cells.

HYPOTONIC SOLUTION

A solution that is lacking in the proper amount of the sodium, calcium and potassium chlorids, owing to the presence of an excess amount of water or of water alone, is a hypotonic solution. A hypotonic solution will cause the cells to absorb the water until there is an equalization which causes the blood and tissue cells to become distended.

HYPERTONIC SOLUTION

A solution that contains more salts than do the blood and the tissue cells is a hypertonic solution. A hypertonic solution will cause the cells to give up the water, producing crenation of the blood cells and shrinking of the muscle and nerve tissue cells. This is one of the commonest causes of postoperative pain.

There were many who overlooked the exact technic for the preparation of the local anesthetic solution, which must be composed of ingredients corresponding to the physiologic laws and functions of the living cells.

SUMMARY OF EXPERIMENTS

The experiments show that the tissue cells return to normal within thirty days after an injection of a hypotonic solution. There is no change in the tissue cells from an injection of an isontic anesthetic solution, but there is a permanent injury to the tissue cells from the use of a hypertonic solution, which may remain stationary, and no further degenerative changes take place. It may be only the beginning of certain conditions which may prove dangerous to the patient's general health and welfare, especially if the solution is used in large quantities.

The foregoing work deals with the action of various solutions and a detailed study of the blood. Further experiments show the effect on the entire circulatory system, especially where a large quantity of a solution has been injected. The privilege to carry on the experiments was given me at the University of Illinois, Department of Animal Pathology, by Dr. Walter Graham, head of the department.

The experiments were carried out on rabbits by removing the blood directly from the heart. A blood count was made before the amount desired for the experiment was removed. Another count was made immediately after the required amount was removed, and the solution was injected directly into the circulatory system through the heart and some through the large vein in the ear. Twenty minutes after the injection of whatever

solution was used, a count was made. Also, a slide was made, blood from the heart, ear and brain being used, to determine the condition of the red corpuscles.

rectly into the circulatory system of the human body a pint or so of a physiologic sodium chlorid solution to replace a similar amount of blood lost from some cause, since we find that subjecting

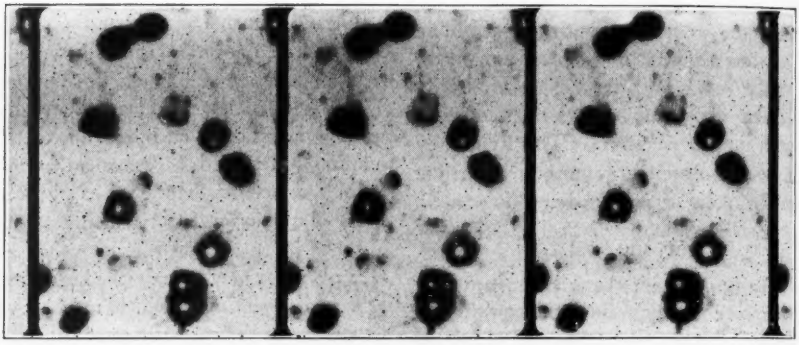

Fig. 3.—Moving picture made from still slide of red corpuscles subjected to a hypotonic (0.7) solution. Cells have become so distended that the centers have ruptured, which leaves only the outer portion of the cell, which would have broken if the solution had been more hypotonic.

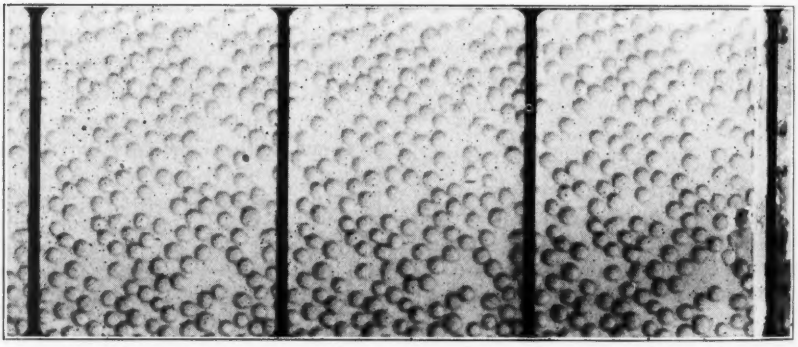

Fig. 4.—Photomicrographic moving picture of normal live red corpuscles that were subjected to a hypotonic (0.7) solution. Viewed under the microscope, they are of a pale yellowish hue, which makes them appear like oranges floating in water while they are in action. In the upper left hand corner, there are ten cells in a row that form a curved line. To show their action and the rapidity by which they move: some of them in the lower frame have disappeared. Some have changed form.

Often, there are cases in which it is necessary to inject subcutaneously or di- the red corpuscles and tissue cells to a solution varying the smallest fraction

from an isotonic will cause a break in the osmotic balance, changing the form of the cells either by a swollen or a contracted condition.

With the foregoing in mind, a series of experiments were carried out on rabbits, as follows:

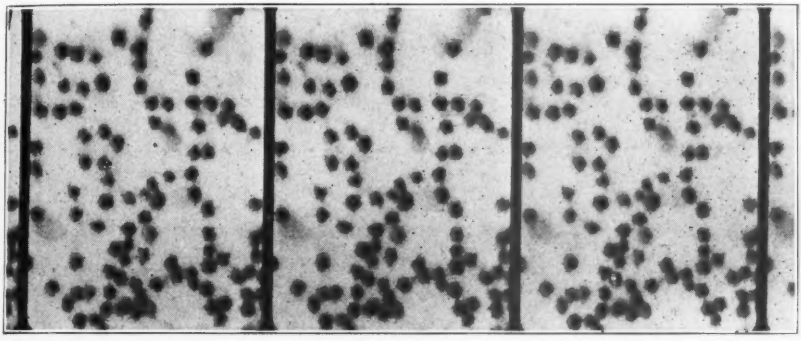

Fig. 5.—Photomicrographic moving picture made from still slide of crenated red corpuscles subjected to a hypotonic solution (1.2 per cent).

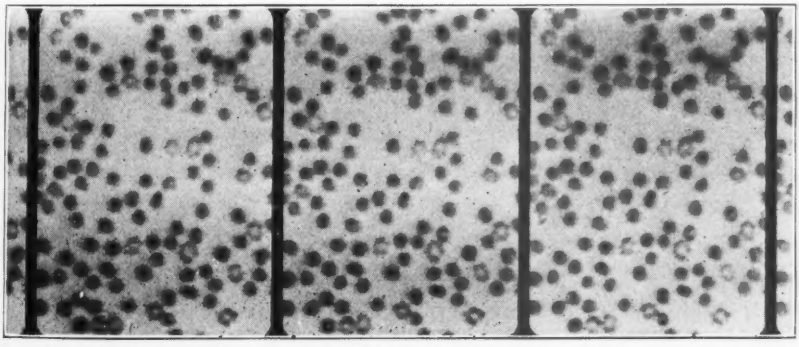

Fig. 6.—Photomicrographic moving picture of red corpuscles that were subjected to a hypotonic solution. Crenation of the cells is evident. Their edges have become roughened and the centers have split, which is characteristic when a hypertonic solution is used, while, in the hypotonic solution, as in Figure 3, the centers are distended.

Experiment 1.—Isotonic Ringer's solution was injected, June 18, at 9 p. m., into a rabbit weighing 2,400 gm. The normal blood count of the rabbit was 4,990,000. After 16 c.c. of blood was removed from heart, the blood count was 2,860,000. Ten cubic centimeters of the isotonic solution was injected immediately, and 20 minutes later, the blood count was 1,720,000. The following day, at 9 a. m., it was 3,000,000; the second day at 9 a. m., it was up to 4,100,000, about the normal.

Experiment 2.—Hypotonic ringer's solution was injected, June 18, at 9:30 p. m., in a rabbit weighing 1,980 gm. The normal blood count was 4,810,000. After 15 c.c. was removed, the blood count was 8,050,000. Ten cubic centimeters of a hypotonic solution

which was 0.6 was injected directly into the circulatory system. The blood count, made twenty minutes later, was 2,600,000. June 19, at 9 a. m., the blood count was 3,130,000. The following day, the count was 3,990,000.

Experiment 3.—June 18, at 10 p. m., blood to the amount of 24 c.c. was removed from a rabbit weighing 2,650 gm. The blood count was then 3,630,000 (normal count, 3,950,000).

A slide was made in each case twenty minutes after the injections were made. The blood corpuscles were taken from the heart and ear. As I was satisfied with the findings, more experiments were carried out, with the same percentages, using blood corpuscles from the heart, ear and

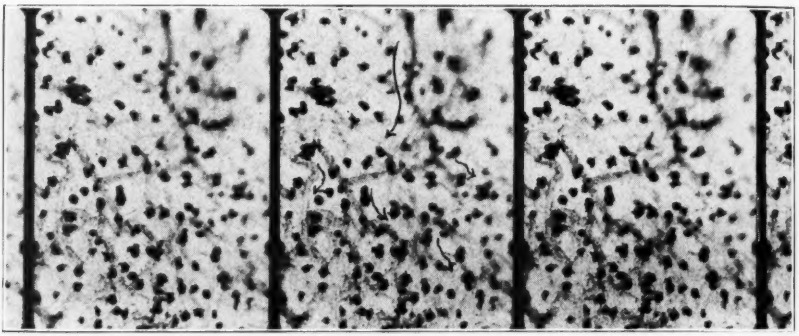

Fig. 7.—Photomicrographic moving picture: web of frog's foot viewed by transmitted light to show capillary circulation. The heavy black spots are pigment cells (chromatopheres). Arrows show flow of cells.

Fig. 8.—Photomicrographic moving picture of the field shown in Figure 7 (higher magnification).

Fifteen cubic centimeters of a hypertonic solution 1.2 was injected, and a count made thirty minutes later showed 2,730,000—900,000 cells short. June 19, at 9 a. m., the blood count was 3,160,000; June 20, 9 a. m., 3,640,000.

brain. The results corresponded to those of the previous experiments. The cells were normal and there were no distorted cells or fragments. These findings will

mean further work to determine what became of the cells that first came in contact with the solutions that were not isotonic. The only theory that can be offered at present is that the distorted or broken cells became lodged in the minute structure at the peripheral endings. with which the cells multiply. According to our leading authorities in physiology, the cells of the body are completely renewed every thirty days.

While going into the study showing the action of a local anesthetic on the blood cells, I thought it would be well to

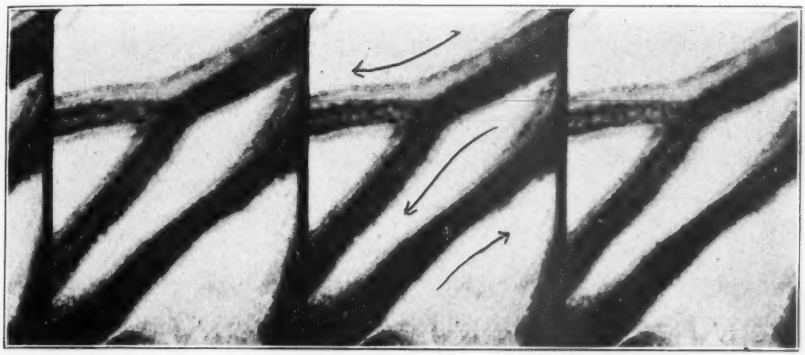

Fig. 9.—Photomicrographic moving picture. This is the same field as is shown in Figure 10, only here the blood cells are shown in normal flow. The arrows indicate the direction of flow of blood cells.

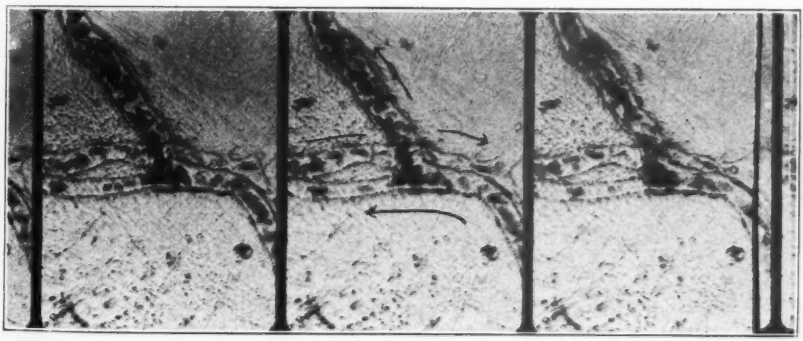

Fig. 10.—Photomicrographic moving picture: mesentery of Necturus maculosus (mud-puppy) viewed by transmitted light to show capillary circulation (direction of blood stream indicated by arrows). Blood corpuscles at the fork of the artery are to be noted.

You will note that the blood count at the end of forty-eight hours in each experiment had just about returned to normal. This shows the great rapidity include the entire field: blood cells in circulation, heart action, showing the rapidity with which the cells travel, and also the heart itself in action alone, as

well as the entire circulatory system functioning, under the microscope in moving pictures.

The experiments reported in 1922,[2] were all carried out macroscopically and microscopically. These changes are now shown under the microscope in moving pictures. On subjecting the blood corpuscles to solutions of various percentages, a great change in the color is noticeable to naked eye. For instance, in placing in each test tube 3 c.c. of normal red blood corpuscles and in tube 1, 7 c.c. of sterile distilled water (hypotonic), in

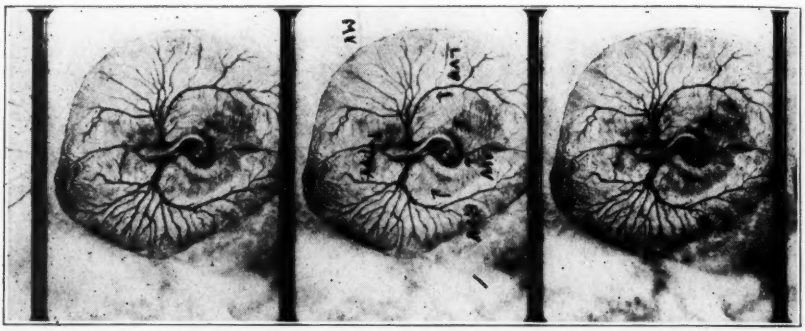

Fig. 11.—Photomicrographic moving picture: chick in third day of incubation, showing extra embryonic circulation (viewed from above). The vitelline arteries are largely obscured by the overlying veins. *A.V.V.*, anterior vitelline vein; *R.V.V.*, right vitelline vein; *L.V.V.*, left vitelline vein; *P.V.V.*, posterior vitelline vein; *M.V.V.*, marginal vitelline vein.

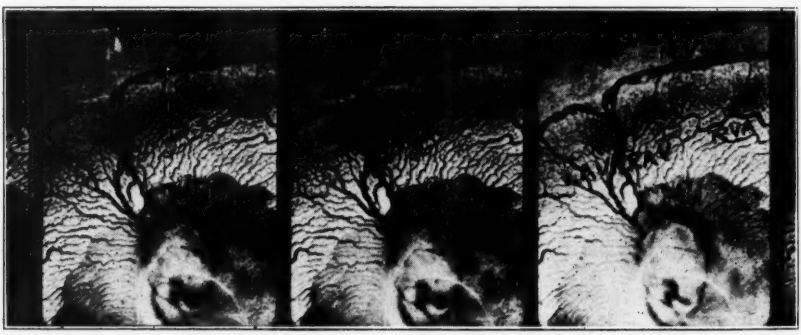

Fig. 12.—Photomicrographic moving picture: heart of chick embryo of three days' incubation, showing extra embryonic circulation (viewed from above). *M.V.*, marginal vein; *R.A.V.*, right anterior vitelline vein; *L.A.V.*, left anterior vitelline vein; *R.V.A.*, right vitelline artery. Change of the heart in each frame is to be noted.

pictures. However, to make a comparison, the still slides of the old method are used for illustrative purposes in the moving tube 2 will be placed 7 c.c. of a normal physiologic sodium chlorid solutin and in tube 3, 7 c.c. of a hypertonic solution

(of 1.7 per cent), and to tube 4, 4 c.c. of a hypertonic (2.55 per cent) was added. When these are shaken well, tube 1 will show a very dark maroon hue. Tube 2 will be of the normal red or scarlet hue, tube 3 will be very much lighter, of a crimson red, and naturally tube 4 will be even lighter than tube 3. Now, we will place those four tubes in a centrifuging machine, prepared and centrifuged at the same time. On the removal of tube 1, all the cells are destroyed by hemolysis, leaving only the coloring matter (hemoglobin) throughout the tube, and on examination under the microscope, no cells will be found. Tube 2 will show a deposit of the cells at the bottom of the tube measuring about 1.5 c.c., the remainder of the tube containing a clear solution, and these cells will be found normal. Tube 3 will show the cells deposited with the remainder of the solution clear, but they will seem less in number owing to the contraction caused by the hypertonic solution, possibly about 1.25 c.c. in the bottom of the tube. On examination, they will show crenation. Tube 4 will show the solution clear with cells deposited with greater contraction than in tube 3. On examination, the cells will be found to show a very badly crenated condition. This type of a solution will cause sloughing of the tissues in which it is injected.

If we study closely the accompanying illustrations, we find a change in each frame of the film of those that are in action. All of the illustrations are enlarged photomicrographic moving pictures made from a 35 m.m. standard size film. Figure 1 was made from a still slide of normal red blood corpuscles. The reason for using the still slides is to make a comparison between the stained cells and living cells in motion. Figure 2 is a moving picture of living red blood corpuscles in action. This is a beautiful field to view under the microscope as well as on the screen, showing cells having rounded and thickened edges. You will note the fullness of the cells, instead of a flattened surface which appears on the still slide. Figure 3 is a still slide of the red corpuscles subjected to a hypotonic (0.7 per cent) solution. The cells have become so distended that the centers have burst only the outer portion of the cell being left, and which will soon break, as if the solution were more hypotonic. In order to photograph these cells in moving pictures, it was necessary to experiment with stains to find one that would be satisfactory without causing any destruction to the cells and would be of the right density for photographic purposes. After experimenting, a stain was found which proved to show satisfactorily the cells in the field individually. No intercellular stain was used, but my modification of carbolfuchsin stain. The next field (Fig. 4) shows the changes in the cells from a hypotonic solution (0.7 per cent). Compare these cells with those in the field of the moving picture view of Figure 2. This will afford some idea of the distension that has taken place from a hypotonic solution. The cells are much larger and show a ruptured center. The change is very rapid during the action of subjecting the cells to the solution; in fact, is almost instant, which makes it very difficult to photograph in moving pictures. Figure 5 is a still slide of crenated red corpuscles which was prepared with my modification of carbolfuchsin stain. The red corpuscles were placed in a hypertonic solution (1.2 per cent). Figure 6 shows normal living red corpuscles that were subjected to a hypertonic solution (1.2 per cent).

Since we have made a thorough study of the blood, showing the action of the various solutions on the corpuscles, I thought it would be well to include a study of the blood cells in circulation as well as the live heart in action. At this point, I wish to say that Mr. Arthur G. Eldredge shares with me in this work as it is through his knowledge of photomicrographic photography that we are enabled to present this work in research to the professions. On studying the blood corpuscles in circulation and the heart in action with the moving pictures, we find a new field for further investigation and study of diseases, use of drugs on the circulatory system, etc., by the use of a high powered microscope with moving pictures. This film proves beyond any doubt that visual education is the ideal means of instruction in this field because the normal arterial pulsation due to the heart action can be seen and the intermittent flow of blood cells due to the systolic and diastolic action of the heart. The latter is well shown in Figures 10 and 12 as you will note the action in the three frames of the moving picture. The blood cells can be seen to change their form in circulation, especially when they will become jammed, so to speak, at the fork, as you will note in Figure 10. It is really wonderful to see the cells going along at the normal speed and then they slow up as if they were going to stop, owing to the action of the heart. The same applies to Figure 7 in the web foot of a frog. In this film, we see the many cells flowing through the capillaries. The capillaries run in a zig-zag course, and we have a beautiful view of the blood cells traveling at various angles, finding their way through to the peripheral endings. Figure 8 is not so clear because of the higher magnification and so does not show details such as are shown in Figure 7.

It is very fascinating to watch the film in action as shown in Figure 9. The blood cells traveling at a normal speed pass through so rapidly that they look like bullets. They are very close together and appear to be traveling by the millions.

Over a period of many years, it has been my desire to complete the study of the blood cells in action, and I hope that this new field will enable many investigators to further their work in the study of the various diseases.

A METHOD OF DETERMINING, QUANTITATIVELY, THE INCIDENCE OF LACTOBACILLUS ACIDOPHILUS-ODONTOLYTICUS IN THE ORAL CAVITY*

By F. E. RODRIGUEZ†, B.S., D.D.S., Washington, D. C.

THE determination of the presence of *Lactobacillus acidophilus-odontolyticus* in dental carious tissue or in the salivary fluid of those susceptible to dental caries depends on the initial employment of an acid broth[1] to which definite amounts of certain sugars, particularly glucose, have been added. This broth acts selectively, that is, its initial acidity inhibits the development of any of the oral bacteria which may be contaminants, except those belonging to the genus *Lactobacillus,* which are characterized by a high acid-resisting power and the ability to multiply to some extent in an acid environment. After incubation for at least seventy-two hours, a pure broth culture of the lactobacillus is usually obtained. Transplants are then made from this broth upon the surface of glucose agar plates or any of the milk-agar products available for this purpose. Incubation of these transplants results in a surface growth containing colonies of the organisms. This method, briefly described above, has in recent years been used, with but slight modification, by practically every student of the bacteriology of tooth decay, particularly by those interested in the incidence and biologic activities of the acidogenic bacilli of dental caries.

It will be noted, of course, that the method heretofore used permits only a qualitative estimate of the bacteria of tooth decay. In fact, the procedure makes

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†Assisted by Thomas H. McGuire.

1. Kligler and Gies (J. Allied Dent. Soc., 10:141-458, 1915), in their pioneer and notable contribution to this subject, used glucose broth with an acidity of from 3 to 4 per cent normal acetic acid. Howe and Hatch (J. M. Res., 36 [March] 1917), in their report of the presence of B. acidophilus in dental decay, do not mention specifically or in detail the technic employed, but it is apparent that they used the method previously reported by Kligler and Gies. McIntosh, James and Lazarus-Barlow (Brit. J. Exper. Path., 3:138 [June] 1922; Lancet, 1:1183-1185 [June 17] 1922), of London, as well as Rodriguez (Mil. Dent. J., 5:199-214 [April] 1922), of the U. S. Army Medical School, applied modern methods of adjustment of mediums by hydrogen-ion concentration determinations and established the p_H ranges most favorable for the growth of the organism. Bunting and Palmerlee (Rôle of Bacillus Acidophilus in Dental Caries, J.A.D.A., 12:381 [April] 1925; Dent. Cosmos, 68:931 [Oct.] 1926) also used titration methods based on p_H methods; as well as Jay and Voorhees (Dent. Cosmos, 69:977-980 [Oct.] 1927), Okumura and Nakai (Shika Gahuko, September, 1926; Bacteriologic Studies on Dental Decay, J.A.D.A., 14:817 [May] 1927), Morishita (J. Bacteriol., 18:181-198 [March] 1929) and others.

it possible for us to determine only whether the case is positive or negative for the lactobacillus, but it throws no light on the preponderance of this organism in a particular inoculum or on the ratio of the different bacteria existing in a definite amount of material under various conditions of mouth hygiene and susceptibility to dental caries. It is clear, furthermore, that a strictly qualitative method of cultivation, such as this, precludes the determination of the effects of treatment aiming at the reduction of the specific bacterial overgrowths from a level of danger to one of relative safety.

For these reasons, we have given considerable thought to the possibility of the development of a differential medium which would allow a quantitative estimate to be made of the lactobacilli contained in a definite amount of salivary inoculum. In other words, a differential count by some modified form of the usual plate colony-counting methods employed in general bacteriology. Our findings in this connection form the basis of this report.

TECHNIC

The individual to be examined is given a small piece of paraffin and instructed to chew it vigorously for two or three minutes and to move the paraffin mass in all directions over the surfaces of the teeth. The saliva accumulating in the mouth during the first half minute is discarded, but that subsequently secreted is collected in a sterile petri dish. The purpose of this chewing is to dislodge as many as possible of the specific bacteria attached to the tooth surfaces and interdental areas, and thus obtain a representative specimen of contaminated saliva. Such is also the reason for discarding the first saliva collected, in which the bac-

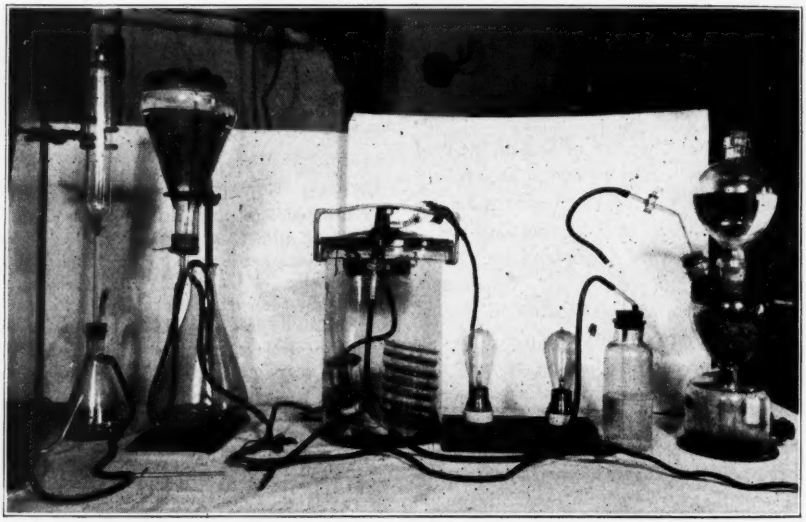

Fig. 1.—Brown anaerobic jar and accessory apparatus employed.

teria are highly diluted by the primary stimulation of the salivary glands induced by chewing the paraffin.

2. Of the saliva collected in the petri dish, as above indicated, 0.1 c.c. is transferred by means of a sterile 1 c.c. pipet into a tube containing 9.9 c.c. of glucose broth p_H 5.8. The tube is labelled No. 1. After the contents of this tube are thoroughly mixed, 1 c.c. of the mixture is transferred to a second tube containing 9 c.c. of the broth medium. This tube is labelled No. 2. Likewise, 1 c.c. is transferred from this No. 2 tube into a third tube and labelled No. 3. This furnishes three dilutions of the original salivary inoculum in broth: first tube, 1:100 dilution; second tube, 1:1,000 dilution; third tube, 1:10,000 dilution.

3. After proper mixing of the saliva-broth content of each tube, a procedure which should not consume over one and a half minutes, 0.1 c.c. portions from each tube are spread over the surfaces of serum-agar plates, the formula for which is given elsewhere in this paper. The plates are labelled according to the dilution indicated on each tube. The inoculated plates are then placed inside a Brown anaerobic jar; the jar is sealed, and the air is partially exhausted by means of a water suction pump. On the completion of this step, a volume of freshly generated carbon dioxid equal to

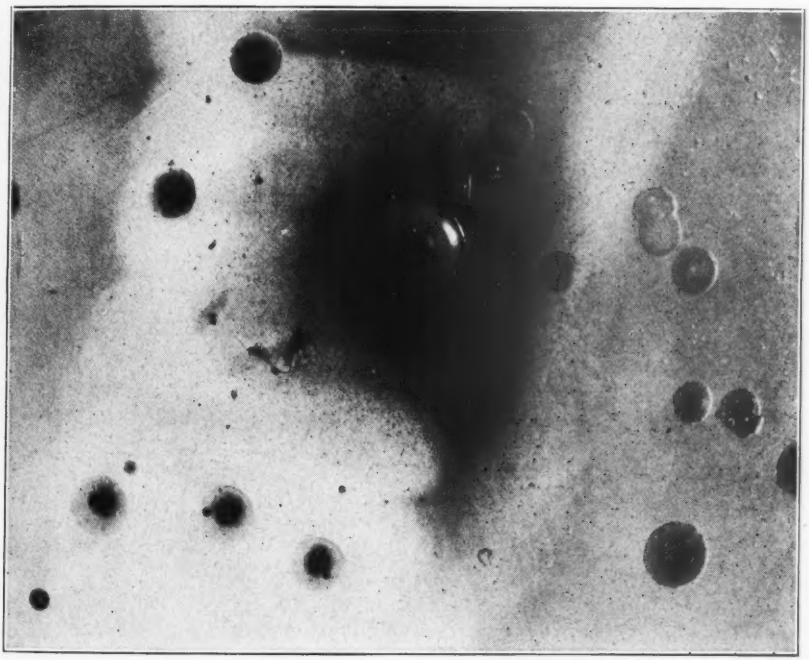

Fig. 2.—Colony of L. acidophilus-odontolyticus grown anaerobically and under the influence of carbon dioxid. The difference in development of the surrounding colonies can be noted.

10 per cent of the capacity of the jar is added. Hydrogen is then allowed to flow into the jar until the condensation of the water formed by catalysis has reached its maximum, and decolorization of the methylene blue solution used as an indicator of anaerobiosis takes place. Under these conditions, the jar, with its content of plates, is incubated for two or three days at a temperature of 37.5 C. The tubes originally used for the dilutions are incubated under ordinary conditions of atmospheric tension and used as a check in case of negative results in the plates.

4. After incubation, any colonies of *L. acidophilus-odontolyticus* developing on the surface of the serum-agar medium will stand out, sharply differentiated from the colonies of the other mouth bacteria. In this medium and under the conditions of its incubation, the organism develops normally as a raised glistening

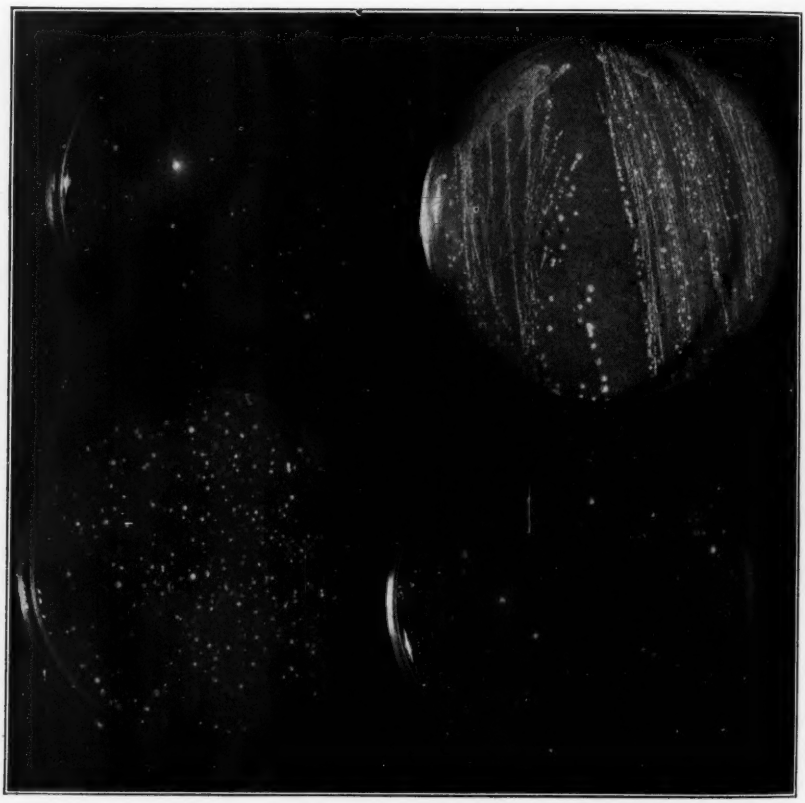

Fig. 3.—Above: Left: One colony of the specific organism. Right: Pure culture, with complete opacity of the whole plate. Below: Left: Negative plate, showing lack of opacity. Right: Several colonies of the lactobacillus.

white, round, smooth-edged colony, of even texture. (Fig. 3.) The colony is surrounded by a distinctive diffuse area of the opacity of the medium to the extent of approximately 10 mm. around its periphery. This opacity does not occur in the case of the other mouth bacteria.

5. A count is then made, and an estimation of the specific bacterial content of the individual examined is made by a simple calculation based on either 1 c.c. of saliva or a fraction thereof. (Fig. 5.)

control growth in case of negative results in the jar cultures. Should the plates in the jar show negative results for the organism, the tube cultures would then be valuable confirmatory evidence, if negative, of the lack of lactobacilli in the material examined. On the other hand, positive results in the control tube cultures and negative plate cultures, such as occasionally occur, would indicate the possibility of deficiency either in the preparation of the mediums or in the mechanism of the jar.

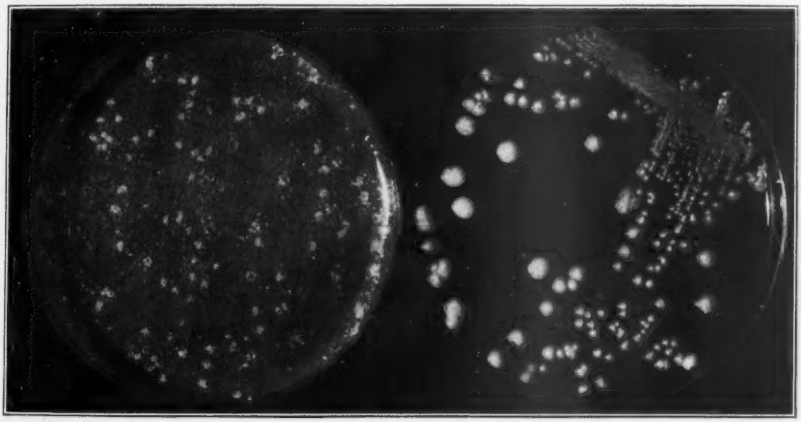

Fig. 4.—Left: Pure culture of strain of L. acidophilus obtained from horse feces. The medium has become cloudy throughout. Right: Pure culture of a mouth yeast. No change has taken place in the medium.

MEDIUMS AND APPARATUS EMPLOYED

1. *Broth for Original Dilutions.*—Either beef extract or infusion broth containing 1 per cent glucose is satisfactory for the purpose. It is adjusted to p_H 5.8. The purpose of this acidity is twofold, as explained in the comment accompanying this paper, but its primary function is furnishing an initial reaction favorable to the development of the lactobacillus in the broth, thus insuring its value as a

2. *Serum-Agar Medium.*—This medium consists of a standard beef extract 3 per cent agar, p_H 7.2, containing 10 per cent horse serum. The agar is placed in a flask of the desired capacity and melted, and the serum is added when the agar cools to a temperature of 55 C. It is then well shaken and poured into petri dishes in the usual way. After solidification, the plates should appear clear and practically like any ordinary solid agar

medium. The plates are then ready for inoculation by the "spread" method.

(Thorough cooking of the basic agar medium is absolutely essential for the success of this quantitative technic. The best results have been obtained by the use of Japanese shredded agar which requires a great deal of cooking in its preparation. American powdered agar may be used provided its cooking is carried out as effectively as in the case of the shredded agar. Strict adherence to the following technic of preparation is recommended:

To make 6 liters of the basic agar mediums, to 6 liters of hot tap water, add sodium chlorid, 5 gm. to a liter; peptone, 10 gm. to a liter; beef extract, 3 gm. to a liter. Stir until all components go into solution. Put in open fire and when the solution is hot, add the Japanese shredded agar in the proportion of 35 gm. to the liter, stirring constantly until it dissolves. Add sodium hydroxid N/1 solu-

Fig. 5.—Right: Platings from second dilution tubes in the case of two patients highly susceptible to dental caries. The specific colonies may be easily differentiated from the others. Left: Platings from third dilution tubes from the same cases mentioned above. The surrounding opacity of the specific colonies is well shown.

tion (10 c.c. to each liter). From the time heat is applied to the agar, there should elapse forty-five minutes of constant heat. After the agar is dissolved, remove it from the heat and place in a cold water bath. Stir continuously until the temperature drops to from 50 to 55 C. Add eggs in the proportion of one egg to each liter and put the mixture back in the stove until hot (not boiling) and the eggs coagulate and come to the surface. Do not let boil. Then turn the heat low. Leave it low until the eggs are cooked solid enough that they can be skimmed off. Skim off the eggs. From the time the eggs were added, the heat should be applied for approximately one and one-half hours. Filter through cotton and gauze. Add 1 per cent glucose. Readjust to p_H 7.4. Sterilize at 15 pounds for fifteen minutes.)

3. *Incubation.*—The inoculated plates are placed inside a Brown anaerobic jar (Fig. 1), which is then sealed with "plasticine" or some other form of modeling clay. By means of a water suction pump, the air inside the jar is partially exhausted. Freshly generated carbon dioxid, produced by the action of 10 per cent sulphuric acid on a saturated solution of sodium bicarbonate, is then allowed to flow into approximately 10 per cent of its volume. Allowance should be made for the space occupied by the plates in estimating the total amount of carbon dioxid required. The production of a partial vacuum by the water pump, as previously indicated, is absolutely essential in order to provide space for the carbon dioxid, as well as to reduce the amount of contained oxygen to such a point that what is left of the oxygen may be easily converted into water by the catalytic action of the coil on the hydrogen, as recommended in Brown's technic. A tube containing a small amount of a weak solution of methylene blue in 2 per cent glucose broth, previously placed in the jar, will act as an indicator of anaerobiosis. Under these conditions, the jar is placed in a large incubator at 37.5 C. Forty-eight hours incubation is usually sufficient for purposes of identification of *L. acidophilus-odontolyticus* colonies, if these are present.

The hydrogen used for producing anaerobiosis in the Brown jar is generated in a Kipp generator by the action of 10 per cent sulphuric acid on metallic zinc. In this connection, it should be added that, if a small crystal of copper sulphate is placed in contact with the solution, it will prevent the collection of too much zinc sulphate on the surface of the zinc and the consequent interference with the free action of the acid. The hydrogen gas should be passed through a solution of sodium hydroxid to neutralize any acid that might otherwise be passed over with the gas.

COMMENT

The technic just described results in the production of a growth on the surface of the serum-agar plates in which the colonies of the lactobacillus of dental caries stand out sharply differentiated from those of the other mouth bacteria. This difference, as previously noted, consists not only in the development of a larger colony (Fig. 2) than is possible by any other method known at present, but also the production of a distinctive surrounding area of opacity of the medium (Figs. 3 and 4); which simplifies its recognition by ordinary visual means. This opacity is a specific acid reaction of *L. acidophilus-odontolyticus* in this particular medium. It does not occur in the case of the other bacteria inhabiting the mouth.

The results obtained by this method of cultivation in the case of this organism are due to the combined action of the various factors in the technic. There is primarily the question of anaerobiosis, which unquestionably plays a leading part.

The organism is normally a micro-aerophil, although it possesses the faculty of adapting itself to an aerobic environment. Under conditions of reduced atmospheric tension, but particularly under strict anaerobiosis, its growth is much heavier in both solid and liquid mediums than when cultivated by the usual aerobic methods. The addition of carbon dioxid introduces a further important stimulating influence which manifests itself in marked acceleration of development and luxuriance of growth. The normal lactobacillus colony grown under the combined influence of anaerobiosis and carbon dioxid environment is large, heavy and of a very rich and even texture. (Fig. 2.) This favorable quality of carbon dioxid has already been known and reported by various investigators, among whom may be mentioned Cohen and Markle,[2] Chapin,[3] Cohen and Fleming,[4] St. John,[5] and Huddleson,[6] all of whom advocated this gas in the cultivation of micro-aerophils. Kulp[7] has used carbon dioxid in the cultivation of *Lactobacillus acidophilus* of intestinal origin, with gratifying results. Valley and Rettger,[8] in a study of the influence of carbon dioxid on bacteria, tested more than 100 organisms, and are of the belief that anaerobic bacteria require carbon dioxid for their development and continued existence. These authors mention *Lactobacillus acidophilus* specifically as requiring for its growth more carbon dioxid than is contained in the natural atmospheric environment (0.03 per cent).

Carbon dioxid, on the other hand, seems to exert a partial but marked bacteriostatic or inhibitory action against the other mouth bacteria when grown under the conditions indicated by this technic. (Fig. 5.) The colonies of organisms other than members of the lactobacilli develop feebly and at times show an atypical structure. This effect is probably due to a lowering of the p_H of the medium by the carbon dioxid, although there is a possibility that, in the case of some bacteria at least, the gas in the concentration used may, through some toxic action, affect cell metabolism. Valley and Rettger,[8] who observed a similar inhibitory action, are of the opinion that a change in the reaction of the mediums is the factor involved. (Figs. 3 and 11.) At any rate, the double effect of stimulation of the lactobacillus, and the partial inhibition of the others members of the mouth flora, occurring simultaneously, is a determining factor in the success of this technic of *L. acidophilus-odontolyticus* cultivation.

The opacity of the medium occurring wherever a lactobacillus colony develops, and nowhere else (Fig. 3), thereby introducing a fine means of specific colony differentiation is, in our judgment, a most interesting phase of this investigation. This opacity is apparently due to acid precipitation of the serum element. For this precipitation to occur, it is essential that the acidity be at least p_H 4. This was demonstrated as follows: Test tubes containing 10 c.c. each of buffered solutions graded in 0.2 gradations from p_H 3.8 to p_H 5.8 were set up in racks. Into each tube was dropped a rectangular strip of

2. Cohen, M. B., and Markle, L.: J. A. M. A., 67: 1302-1303, 1916.

3. Chapin, C. W.: J. Infect. Dis., 23:342-343, 1918.

4. Cohen, M. B., and Fleming, J. S.: J. Infect. Dis., 23:337-341, 1918.

5. St. John, J. H.: M. Rec., 95:184-186.

6. Huddleson, I. F.: Michigan Agr. Coll. Exper. Sta. Tech. Bull., No. 49.

7. Kulp, W. L.: Science, 64:304-306.

8. Valley, G., and Rettger, L. F.: J. Bacteriol., 14: 101-135 (Feb.) 1927.

the freshly prepared, uninoculated serum-agar medium, of such a size that each strip was completely submerged yet visible through the wall of the tube. The set of tubes were then placed in the incubator at a temperature of 37.5 C. At the end of fourteen hours, opacity had occurred in all tubes labelled p_H 3.8 to p_H 4.2. The strips in all the remaining tubes of lesser acidity were unchanged.

The correlation of this experiment with the observations noted when actual cultures are used lends strength to the belief that the lactobacillus of tooth decay produces practically the same acid concentration in colony form as it does in fluid cultures, provided, of course, certain essential environmental conditions are first established. It further emphasizes the previous claims of McIntosh, James and Lazarus-Barlow[1] and Rodriguez[1] that a localized acidity of p_H 4, essential for the inauguration of the carious process, is to be expected of this organism when its colonization upon the surfaces of the teeth remains undisturbed.

CONCLUSIONS

1. This report presents a new technic of determining, quantitatively, the incidence of *L. acidophilus-odontolyticus* in the oral cavity by the employment of a plate colony count method.

2. The serum-agar medium here reported, under the influence of anaerobiosis and a carbon dioxid environment, stimulates the growth and development of this organism and differentiates its colonies from those of the other mouth bacteria by a specific reaction on the serum content of the agar.

3. The employment of this technic of cultivation makes possible the determination of the effects of dental caries control methods by providing the means of checking the actual reduction or disappearance of the bacterial factor involved as a part of the process.

SENSE PERCEPTION AND SPEECH INEQUALITIES: THEIR SIGNIFICANCE

By F. ALBERT DONLAN, M.D., Atlantic City, N. J.

WITH the advent of the cinema, there has followed an avalanche of suggestions, criticisms and opinions regarding its value and uses. In common parlance, we are said to hear with the ears, see with the eyes and taste with the tongue. In reality, these organs are adapted to receive impressions.

Through their respective nerves, impressions are conducted to the brain, where they are received and transformed into pictures, and projected definitely, as a special sensation.

Perception is the habit of referring sensation to causes outside ourselves. The reality of the external world depends, then, on our ability to project sensations.

Daily experience affords an opportunity to attain a knowledge of external objects. Ability, degree of success, fitness or confidence is evidence of the particular conduct of the individual senses.

It follows from the foregoing that opinion will be a matter of the individual's judgment. Too often, judgment is based unconsciously upon sensations. In such an event, it is questionable. Unless judgment is based upon many things other than the individual's conception of the appearance of objects, and his appreciation of sound, recommendations or suggestions will not be constructive, but hypothetical, dubious or worthless.

In the animation of the screen, there has been evolved, so to speak, a "sixth sense," namely, synchronization of vision, speech and hearing. In order that it may be impressive, agreeable, pleasing and entertaining, there must be a proper coordination of all conditions essential for the production of a coherent creation.

Metallic, adventitious or artificial qualities must be reduced to a minimum or eliminated, before speech or voice will become anything other than a detriment to an otherwise good production.

Movements of lips or mouth, exaggerated in an effort to adapt the voice to a circumstance, become objectionable. The impersonation or articulation, enunciation and phonation demand skill and experience for agreeable and pleasing execution.

Since many voices when projected have a spurious or unattractive quality, not unlike that which would result from the wearing of a faulty denture, the result of an affection of the larynx or nose, or an impediment of speech, there will be opportunities for experimental work in voice correction.

Pathologic and physiopathologic problems will arise. Investigations in this field will take on a new vigor, and no doubt many will become proficient in handling these problems by virtue of concentration and interest.

Gross and obvious disturbances of speech are very common. Wonderful progress has been made in many respects, through surgical intervention and intelligent management. Because there are relatively few interested in the subject; because of social rather than economic disadvantages and because of a lack of means to engage a competent clinician and a lack of clinics for study and corrective work, disturbances of speech or voice which are remediable have become prevalent.

Malformation or diseases of the external phonetic apparatus; acquired or congenital defects of phonation; organic conditions (general paralysis, disseminated sclerosis pontobubar lesions), promoting the most serious disturbances; paraphasic disturbances (substitution of one word for another, incessant repetition of syllables or words or forgetting certain words difficult to use), observed in various intoxications, arteriosclerosis, cerebral arteritis and mental affections; aphasic disturbances: word deafness, psychic deafness (sound), word blindness, psychic blindness (pictures and objects) and articular motor aphasia (meaningless sounds); agraphia, constitute a group of disturbances requiring physiopathologic study. (Martinet.)

An entire volume would not be sufficient to describe affections of the auditory apparatus and the phenomena of vision or to outline procedures useful in detecting or correcting any impairment of function.

Throaty, wheezing, metallic nasal or guttural tones will eventually disappear and in their place will be a natural clear voice. Since many elements enter into the production, transmission and projection of sound, many details will necessarily have to be mastered. Inequalities due to tone or pitch will be either over-

corrected or modified to suit the occasion. At present, there are few workers in this field, but ultimately there will be put forth much effort, not only in testing the voice, but, what seems more important, in eliminating inequalities by corrective measures.

Success in the endeavor will not depend on the efforts to discount one's voice quality, but, in a larger measure, will be assured by actually eliminating inequalities, if only in some small way. The "vocotone" is a name given to a device now in use for testing screen candidates. I am not familiar with its qualities or field of usefulness. With advancement, no doubt there will follow mechanical means of precision. To be disqualified in any chosen field is a disappointment likely to discourage an otherwise skilful individual. To remedy or restore to usefulness is an accomplishment worthy of admiration.

With the radio and the mechanically perfected phonograph, there will be a concerted effort for the success of speech or voice which is most significant.

In this field, the clinician and the dentist who are peculiarly fit by virtue of their knowledge concerning physiology, physics, technical skill and anatomy will have an opportunity to take up the work where the layman falls down. Like numerous other efforts, it will be well handled by many, missed entirely by others and mastered by a few.

Perfection will require a detailed study of the individual, and attention to every factor which enters into the question of success. One will not need to be a master of music or an elocutionist, but he will require at least some conception of these arts. There will come a call for ingenuity, mechanically and clinically.

Certain subjective influences may add a negative quality to the voice. They are too numerous to mention here, and frequently are determined only by a careful analysis of the individual. The audience will not be without consideration concerning all factors or elements which impair transmission of sound either subjective or objective. The presence of or impaction of "wax" or any other interference with the sound-conducting apparatus may be responsible for lack of appreciation, and the individual be unaware of such an affection. Visual disturbances or distance from the images and projected voice; head noises of reflex origin and diminished acoustic power due to affections of the accessory sinuses undoubtedly interfere with sound production and perception. These are among the simpler obstacles to success, and no doubt many not subjective in origin will be removed in a mechanical manner.

It is not possible to offer a course in the practice of medicine with each production, but it is a simple matter to prevent failure by the generous distribution of knowledge which will minimize faults in sense perception. There are many people throughout the world who never have any normal sense appreciation because of individual impairment, however hard they may strive to understand.

Vision is projected from the brain through the eyes. The impression is received by the retina of the eye "upside down" and projected by the brain, through the special nerves to the eye, then to the outer world in the erect or proper position.

The enunciation and pronouncing of vowels, consonants and syllables, if not well coordinated, can be modified in transmission or simplified by recasting the sentence. Clumsy or wordy statements must be avoided. Contractions

which would otherwise mar a good projection must be eliminated. A succession of like words or sounds difficult to project would prove disagreeable.

The proper subordination of words relative to style and sound will become an art. The selection of well coordinated sentences, considering all elements; choice of words, ease of pronunciation and enunciation; simplicity and adaptability to the particular voice will reduce the likelihood of untoward qualities.

Many things concerned in the mechanism of voice production will be gradually mastered. The intellect is of prime importance, and without the ability to appreciate varying changes and circumstances, everything which constitutes expression or esthetic beauty, even with every known means and technical resources at hand, becomes a difficult matter.

Sound is transformed within the ear and perceived in the brain. It is not projected without the ear as it may seem. When sound waves are interrupted or received by the drum head in an improper manner, there is an inequality.

Sound is the result of the vibration of the true vocal cords by expired air passing over them. Modifications of sound are produced by the tongue, lips and teeth. The sounds forming the vowels are generated by the larynx. The sounds for the consonants are produced by the interruption of the currents of air in some parts of the air passages above the larynx. The intonation of consonants follows their proper combination with the vowels.

Sound is modified by the varied forms of the oral cavity. Vocal sound is produced by the true and the false cords. The cords are elastic and have the property of vibration because of muscular control. The larynx is the organ of voice and houses the sound mechanism. The larynx emits sounds and the oral canal or oral opening changes one and the same sound into different vowels. Pronunciation of words is accomplished in this manner.

Speech is the production of the human voice in obedience to the cerebrum or brain. Speech consists of the articulate sounds which are the vowels and consonants. In vocalization, the aperture between the cords, etc., is narrowed, the edges of the cords approximate and a note is emitted. The higher the note, the tenser will become the cords. Range depends on the tension of the cords and the degree of approximation.

There are three kinds of sequence of laryngeal notes: the monotonous, when the notes are nearly all the same pitch; the expressive, or a successive transition from high notes to low; the musical, which is determined by the number of vibrations in the successive sounds and their relative properties. The variety of sounds in speech is due to articulation in the mouth.

The essential difference in voices is in tone or timber. The baritone and mezzo-soprano occupy a middle position as to pitch. The tenor displays ability to interpret high notes, the bass that of the low note. Either extreme may find difficulties in projection. The soprano reaches the highest note in the series, while the contralto reaches the lowest. The lowest note of the female is about an octave higher than that of the male. The entire scale of voices (compass) constitutes about four octaves. All sounds of the explosive type are not susceptible of combination. The tongue, although playing an important part, is subordinate in pronunciation.

In the theory of sound, the palate receives but little mention other than concerning its abnormalities. Failure of or

faulty fusion constitutes a serious disturbance not only in the acoustics of sound, but in all other elements however small. The oral surgeon has long contributed his part in their correction. Further, the artificial denture, aided by mental influence, has been the means of correcting voice more often than occasionally.

When there exists an aperture in the palate or absence of a given amount of soft palate because of deep ulceration or operative injury, the air current is diverted into the nasal cavity. Sound is therefore influenced in its course of projection and enunciation. Pronunciation and phonation are impaired.

Absence of teeth, the presence of supernumerary teeth, disturbed occlusion, affections of the salivary or parotid gland resulting in an excess or deficiency of saliva, faulty or clumsy restoratives such as massive or cumbersome bridgework, false teeth, unnecessary "wiring" as a means of anchorage, affections of the tongue, etc., have all been responsible for adventitious sounds. The simpler disturbance, if neglected or unrecognized, disturbs the harmony of all factors entering into the esthetic qualities of the voice.

The dentist must exercise his observation as the clinician, learning to scrutinize the pharynx or to detect possible disturbance in the nasal cavities or maxillary sinus. He must observe the gross characteristics of the pharynx and nasopharynx. Size, shape, relations and appearance of the tonsils; presence of adenoids; presence or absence of scars or adhesions, the general conduct of the muscles about the mouth as related to speech, whether drawn to one side, limited in movement or opening wide.

Auditory perception must be taken into consideration. When such a survey has been made, a study of the mentality becomes necessary before any degree of success can be assured. The patient must cooperate.

Even if far from what is believed to be a field for activity, there is without doubt an opportunity afforded by virtue of special skill to correct impairment of voice at an early age and often in an incipient form in adult life. Radical measures have already done much to correct gross irregularities.

Muscles are controlled by innervation through the neurons, afferent fibers or sensory and efferent or motor nerves. Any interference, functional or otherwise, with the nervous mechanism controlling the respective muscle or muscular balance will cause incoordination. The stability of the dental arch is dependent on freedom from any such influence. It follows, therefore, that any perverted functional effort in muscular balance within or about the oral cavity or peculiar to the mechanism of the larynx, whether it be biologic, anatomic, physiologic or pathologic, will influence sound and necessarily the elements entering into voice or the esthetic resources of vocal expression.

Chorea, habits, hysteria, tetany, facial or Bell's palsy and neurasthenia will serve to emphasize any perversion or promote a functional condition. In such cases, the underlying cause, once it is recognized, must be treated.

Aphonia may be manifested either in a complete suppression of sound, whispering, or the inability to produce sound other than after long intervals of suppression and then only for a few words or a few hours. A syphilitic, tuberculous or diphtheritic affection may involve the larynx, either through innervation or structurally. All gradations of impairment are manifest in tuberculosis or syphilis. Toxins of the diphtheritic or-

ganisms have a special affinity for the laryngeal nerve. Menstruation, pregnancy and the menopause have a physiologic influence upon sound production or the vocal cords. Not infrequently, there is a complete aphonia at the menstrual cycle. Further, women who are constantly using the voice should remember that there is always danger of impairment at the time of any physiologic phenomena.

Sigmatism is a term used to denote a perversion in the use of the voice, i.e., substitution of sounds, faulty pronunciation and the repetition of words or syllables; in a word, stuttering or stammering. The causes are numerous, psychic, physiologic, biologic, anatomic, hereditary (hypertonous of muscles, enlarged tonsils or adenoids, unusually small or large lips, dentures).

Sigmatismus interdentalis is observed in hysteria or mimicry, or it may be a habit, or the result of faulty occlusion or inharmonic occlusion encroaching on the tongue, or a long tongue. The voice possesses the quality of lisping.

In *sigmatismus lateralis,* the muscles are drawn to one side in an effort to speak. The teeth may show at the angle of the mouth. Dental defects must be eliminated.

In *sigmatismus nasilis,* pronunciation and enunciation are interrupted because of an aperture in the palate or a defect of the soft palate permitting air to flow through the nose rather than over its natural course.

In *sigmatismus stridans,* there is a hissing sound, the cause of which may be the tongue or teeth.

Hurried or excitable speech prompts stuttering. A stutterer may be able to recite, sing or whisper.

Among the many things said to be responsible for speech defects or impairment of sound are: hysteria complex, lack of confidence, "stage fright"; lack of preparation or concentration; lack of sense perception; lack of knowledge of etymology; evil influence of so-called "voice culturists" who are ignorant of all anatomic, physiologic and pathologic influences and who very often subject the voice to the strain of unsuitable composition or composition not adapted to the voice; faulty acoustics, and intra-nasal and aural conditions.

It is impossible to give or endow any person with a voice by any known methods of adding an esthetic quality. One may be capable of correcting faulty technic or developing good qualities, but the essential must be there.

Restorative methods are numerous, but any of them to be of use must be placed on a clinical background. Adventitious qualities may be added by faulty use or overuse of the voice; excesses of tobacco or alcohol, not because of the effect on the voice, but because of the effects upon the neurons, the activators of muscular energy; injudicious use of food, an excess or a deficiency.

Success or excellency irrespective of modern ideas or research is no criterion of what the future holds for those not so heavily endowed with anatomic, biologic or physiologic graces. There are exceptions to any rule or practice, but the great artists have a reverence for all things requisite to success, and it is on sound clinical deductions that they depend for knowledge rather than presumptive reasoning.

A. Buzzi Peccia states in a reprint from "How to Succeed in Singing" published in the *Musical Courier,* Jan. 17, 1929: "Other people believe that the art of singing is the most complicated thing on earth, a labyrinth of rules which no teacher could explain correctly, because,

in order to do so, he should have to be a great artist, a great musician, a physician, a scientist, a throat specialist, and an expert in all the anatomical contractions of the vocal organs, muscles and ligaments of the human body, and a polyglot. There is only one point on which both extremes agree, and that is, that 'anyone is competent to judge,' that is why, in vocal matters, there are so many advisers (and such advisers). The gamut of the opinions ranges from the simplest ingenuity of a child to the incredible absurdities of the quack."

The medical and dental profession should feel flattered, if only for the moment. This author appreciates the wisdom of talent and of the professions of undisputed worth to mankind, and incidentally the folly of an unwise counsel. When men who have achieved fame in an art express themselves in such terms, it is either an indication of respect for the ideals of the profession or an encouragement for the earnest workers. It therefore behooves the medical and dental professions to rise to the occasion. If they cannot produce "singers," they can at least be of inestimable value in assisting humanity to perfect God-given functions and graces, namely, by preventing or removing functional, anatomic and pathologic affections. The reward will be for a few at least, social and economic usefulness.

The day when the medical and dental professions can with assurance volunteer the advice that "no further attention is necessary" is a long way off. When health measures reach beyond pathologic conditions, that is, the obvious, and take cognizance of the latent and functional, such an assurance will be more opportune.

It is wiser to preach the advisability of regarding health as a human endowment having a very definite, and positive relation to all activities affecting the individual socially or economically.

CONCLUSION

A psychologic phase, an enthusiasm, captivates humanity in any march of progress. As the era advances, a more serious or constructive period develops. Each industry presents medical problems peculiar to itself and, in consequence, preventive or curative measures follow. Affections and diseases peculiar to various industries have been well handled in the past by clinical efforts and, in this respect, medicine has played no small part in stabilizing industry.

There is no doubt that the medical and the dental profession will realize the vast opportunity accorded in the improvement, correction and prevention of imperfections in sense perception and inequalities of speech or voice. They will take the work up where the layman falls down.

Studios, conservatories, schools and teachers will, as a result of this consciousness on the part of the public, eventually cooperate with the clinician. Although this will be a field which the charlatan will invade, the gullible will learn and soon turn elsewhere. There will be an incentive for group work, the basis of which will be diagnosis. The dentist will be an indispensable factor.

Today, irrespective of age, occupation, intelligence or financial status, the world is more health conscious than ever before. People are actually trying to abide by the admonitions of the professions. It is becoming each year a more difficult problem for the imposter to proceed unmolested.

As long as the public tolerates inequalities or deficiencies and until remedial measures are assured, the producer will

necessarily view the situation from the economic or commercial aspect. However, realizing what the future holds forth; standards for qualification and production will evolve from knowledge gained in pioneering. There is no doubt that there will come a demand for clinical skill and, with this thought in mind, the professions should be forewarned.

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CAVERNOUS SINUS THROMBOSIS*

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THE fact that infections about the upper lip carry with them a danger of possible involvement of the cavernous sinus is of importance to the dental profession. In extending toward the sinus, the infectious process of the upper lip travels first by way of the facial vein. From the facial vein, a septic thrombosis may extend in two ways: (1) upward through the ophthalmic vein to the cavernous sinus and (2) downward through the posterior facial vein to the external jugular or through the common facial to the internal jugular vein.

Dixon[1] gives four reasons for the importance of infections about the upper lip and the nares as foci of septic thrombosis of the cavernous sinus. These are: (1) early and frequent trauma, (2) absence of subcutaneous fat on the upper lip, (3) the active muscular supply of this region and (4) the inability of the veins that drain this area to collapse.

CASE REPORTS

The following case is illustrative of the clinical course of such an infection and of the damage that may be done by ill-timed tooth extraction:

CASE 1.—A man, aged 58, sought dental advice, July 8, 1929, because of swelling over the upper right cuspid area. Examination showed both lateral and cuspid incisors to be badly broken down and the presence of an acute abscess was suspected. The dentist consulted made an incision high up on the gum and inserted a drain. Pus was not found. The patient was advised to apply hot fomentations and to use a cathartic. The following day, the drain was removed and the area irrigated. The swelling seemed to be mostly in the lip. The next day, a fissure, from which pus was flowing, was noted at the median line when the lip was raised. This opening in the lip was irrigated with a chlorin solution and a drain was inserted. For the next three days, the patient used hot applications at home, and the office treatment consisted only of irrigation and changing the drain. July 15, the swelling had entirely disappeared and the condition was apparently normal, although the patient's physical condition was very poor.

September 7, i. e., about three weeks after complete subsidence of the symptoms of infection in the lip, the patient, who was then in another city, had eighteen teeth removed, on the advice of a physician. Gas anesthesia was used. For several days after the extraction, he seemed to improve generally, but after one week, the upper lip began to swell. On his return to Chicago the next day, the swelling was more pronounced. The following day, September 16, his condition was much worse, and the family physician was called. He advised heat and prescribed internal medication. The swelling spread until it involved the orbit and the side of the face and extended down on the neck. The patient

1. Dixon, O. J.: Pathologic Examination in Cavernous Sinus Thrombosis as a Guide to Diagnosis, Prognosis and Treatment, J. A. M. A., 87:1088 (Oct. 2) 1926.

was in a severely toxic condition and, on the physician's advice, he was removed to the Cook County Hospital on the evening of September 16.

Examination showed that the patient was poorly nourished and seemed acutely ill. The temperature was 103.2; pulse, 140; respiration, 36. There was a hard, indurated cellulitis of the right half of the upper lip and part of the lower lip and of the right side of the neck and right cheek, extending upward to the eye. At the right corner of the mouth was a bruised, ecchymosed, encrusted area. The intra-oral mucosa was injected and edematous and showed evidences of numerous recent extractions.

Fig. 1 (Case 1).—Patient, aged 58, whose death followed extraction of eighteen teeth.

The following day, the patient was stuporous and restless and had involuntary defecation. There was some proptosis of the right eye, which had become fixed; right orbital cellulitis, with edema and injection of the conjunctiva. The ophthalmologic findings were: complete external ophthalmoplegia, proptosis and chemosis on the right side. The right pupil, about 3.5 by 3.5, reacted slightly to light. Accommodation was not determined. The right fundus showed engorgement of the veins, some slight blurring of the disk margin, and venous pulsation. The left fundus was negative. In the afternoon, the patient became delirious. Cheyne-Stokes respiration was present and some edema appeared in the left eye. The temperature was 104.8; pulse, 128; respiration, 36. Death occurred that evening.

Postmortem Findings.—Necropsy revealed extensive cellulitis involving the right half of the upper and lower lip and the right side of the neck, with chemosis of the right eye and thrombosis of the right half of the cavernous sinus and the right external jugular vein; multiple septic infarcts in both lungs and recent fibrinous pleuritis; infectious

Fig. 2 (Case 3).—Appearance of patient in a fatal case of cavernous sinus thrombosis following the scratching of a pimple in the nose.

softening of the spleen; cloudy swelling of the liver and kidneys; eccentric hypertrophy of the heart; moderate sclerosis of the coronary arteries; slight atheroma of the aorta; slight syphilitic aortitis in the region of the arch; arteriosclerotic pitting of the kidneys; sclerosis of the medium sized arteries, especially of the base of the brain; ancient encephalomalacia in both thalami optici and the right nucleus dentatus.

In this case, it may be assumed that there was residual infection in the lip at the time of the extractions, three weeks after subsidence of the swelling.

The second case here reported did not start with infection of the lip, but there was evidence of acute inflammation in the cheek at the time a tooth was removed.

CASE 2.—A woman, aged 57, admitted to the Cook County Hospital, Oct. 6, 1926, had, two weeks before, developed swelling of the cheek for which she was advised to have a tooth extracted. This was done, but the swelling continued. One week later, she had a chill, with pain in the right cheek which extended up over the eye. Pain had been present ever since. General examination showed that she was acutely ill. The right cheek was greatly swollen. The teeth remaining were in poor condition, and the glands in the right submaxillary and submental regions, swollen and tender. There was an abscess on the inside of the right cheek. The temperature was 101.8; pulse, 88; respiration, 22.

Fig. 3 (Case 4).—Appearance of patient, whose condition was diagnosed as cavernous sinus thrombosis.

For the first three days after admission, the condition was fairly good. The temperature varied from 98.6 to 103. October 8, the abscess on the inside of the right cheek was opened. Half an hour later, the patient had a chill. On the following day, a large fluctuant abscess of the right cheek was opened externally and much foul, greenish pus was evacuated. The findings at this time were as follows: The right eye was swollen, with bulging of the eyeball, the lids and conjunctiva were edematous. The lateral portion of the right disk was pale yellow and, seemingly, gave early signs of choking. The left eye was swollen, with edema of the conjunctiva. No definite changes were present in the left fundus. A few rales were noted in lower lungs posteriorly, but there was no consolidation. Examination with transillumination showed that the frontal sinuses were normal and the right maxillary sinus was quite dark. The knee jerk was absent on the right and diminished on the left. The presence of Kernig's sign was suggestive and there was some neck rigidity. The urine was normal. The white blood count was 25,500. The ear-

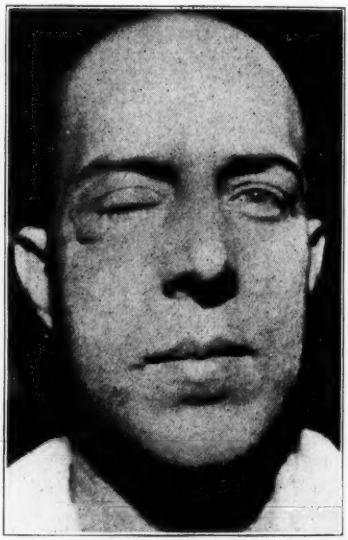

Fig. 4 (Case 4).—Appearance of patient after drainage of cheek and orbital abscesses. Recovery was complete.

drums and mastoids were normal. The heart was rapid, with tones soft and no murmurs. The patient was perfectly rational. The spinal fluid was under increased pressure. Twenty cubic centimeters was removed. It was moderately turbid and contained 1,200 cells, mostly polymorphonuclears.

The morning of October 10, the temperature gradually rose from 98.2, to 103 at 1:00 p. m., when the patient became very restless and had to be restrained. The next morning the temperature was still high and the patient fell into a semi-comatose condition. Death occurred that night.

Postmortem Findings.—Necropsy revealed: suppurative thrombophlebitis of the cavernous sinus; purulent leptomeningitis at the base of the brain; hyperemia and edema of the brain and acute hydrocephalus internus; edema of the conjunctiva of both eyes, especially the right; abscess in the right maxillary region with a draining surgical incision; multiple metastatic abscesses of both lungs; acute degeneration of the myocardium; acute septic tumor of the spleen; cloudy swelling, edema and fatty degeneration of the liver; a recent infarct of the left kidney; cholelithiasis and hydrops of the gallbladder; cellulitis of the right cheek; absent and carious teeth; suppurative gingivitis of the right upper jaw; pyorrhea; suppurative hypophysitis; icterus levis.

The following case has no direct dental bearing but is interesting as showing how slight a cause can lead to this extremely grave complication.

Case 3.—A man, aged 26, five days before admission, had scratched a pimple just inside the left nostril. One day later, there was a swelling of the nose, the left side of the face and the eye, accompanied by chills, fever, frontal headache and vomiting. On admission, July 16, 1927, the patient was acutely ill and very restless. The left side of the face was extremely swollen, red, glistening and tender; the eye was closed. Inside the left ala was an edematous, indurated lesion, which was discharging and tender. Examination of the right eye was negative except for absence of the corneal reflex. The left eye was swollen shut, tender, under tension, proptotic and immovable. The corneal reflex was absent; the conjunctiva was injected, and the constricted pupil did not seem to respond to light. The neck was slightly rigid. The white blood count was 17,500. Spinal fluid examination showed pressure four plus. The reaction to Pandy's test was two plus, to the Ross-Jones test, two plus. Queckenstedt's sign was positive. Turbidity was noted. The cell count showed 305 polymorphonuclears. The following day the patient was delirious at times; the temperature varied from 102.2 to 104.2. He became worse, and, July 19, three days after admission, was taken home by his mother, in a critical condition. Death occurred the following day.

One must occasionally differentiate between an orbital cellulitis with bulging of the involved eye and bulging of the eye due to an early cavernous sinus thrombosis.

Case 4.—In a case referred for differential diagnosis between orbital cellulitis and cavernous sinus thrombosis, the angular vein had been ligated after the latter condition had been diagnosed by the eye department of the Cook County Hospital. The infectious process had its origin in an infected upper tooth, which was followed by cellulitis of the cheek. When the patient was referred, he had an abscess of the cheek, which was drained.

I expressed the opinion that this was not a case of cavernous sinus thrombosis, because the swelling involved the upper and lower lids, and I believed that this was an extension of the inflammatory process in the cheek. Later, an orbital abscess developed. This was drained, and the patient recovered completely.

THE RELATION OF VIRULENCE TO COLONY VARIATION IN THE STREPTOCOCCI*

By FAITH P. HADLEY, M.S., Ann Arbor, Mich.

IT is a common observation that streptococci, although virulent for laboratory animals when first isolated from the human body, rapidly become nonvirulent on artificial cultivation. This is especially true among the green producing and indifferent types of streptococci, but it is frequently noticed among hemolytic strains as well. Several investigators have recently noted that variations in the cultural characteristics of hemolytic streptococci, particularly those of colony form, accompany this change in virulence, but there have been few reports of such observations on the green producing streptococci, and none to the present time on strains of streptococci from pulpless teeth.

Cowan,[1] in 1922, demonstrated that alternate transfers of hemolytic streptococci in broth and on agar over a period of four months, accompanied by continuous selection of the smoothest and of the roughest types of colony, respectively, eventually yielded two distinct types of streptococci. One was the so-called "smooth" type, growing in broth with an even turbidity, appearing in short chains and forming on agar smooth, translucent, finely granular colonies. The other was the "rough" type, growing in broth as a precipitate, occurring in long chains, and showing on agar smaller, opaque colonies, coarsely granular, with irregular outlines. The "smooth" or "S" type was reported as more virulent for mice than the "R," although the difference in mortality between the two series of mice was not clear-cut. There was no difference in hemolytic power of the two types. Cowan also included in her studies two strains of nonhemolytic streptococci, and although she produced R types from the S, neither R nor S appeared to be virulent for mice.

In 1923, Walker[2] reported that from the pleural exudate of rabbits injected intrapleurally with the so-called normal type of *S. hemolyticus,* two forms of hemolytic streptococcus colonies could be obtained: the "normal" type, showing some but not all of the characteristics of Cowan's rough strains, and a very large, moist, smooth colony which, on artificial cultivation, soon reverted to the "normal" type. The "normal" strain did not give rise to "moist" colonies outside the animal body. Intravenous inoculations of rabbits proved the moist type to be distinctly more virulent than the "normal."

Rosenow,[3] in his study of a streptococcus from influenza, and its relation to encephalitis, stated that when the organism was in its virulent or "pneumotropic phase" (occurring in influenza), it pro-

*This work was made possible by a grant from the American Dental Association.

1. Cowan, Mary L.: Brit. J. Exper. Path., 3:187 (Aug.) 1922.

2. Walker, J. E.: J. Infect. Dis., 32:287 (April) 1923.

3. Rosenow, E. C.: J. Infect. Dis., 33:531 (Dec.) 1923.

duced moist, mucoid colonies; but that, as it became less virulent during cultivation on artificial mediums, it became "neurotropic" in its tendencies (causing encephalitis in rabbits), and then produced dry, green colonies on blood-agar.

The investigators mentioned above have thus correlated the smooth, moist type of streptococcus colony with virulence, and the rough, dry type with lack of (or lessened) virulence. This conforms with results obtained in recent years with many other organisms. More recently, reports have appeared which indicate that, among hemolytic streptococci at least, the reverse is true. Todd[4] reported that strains of hemolytic streptococcus from puerperal septicemia, when freshly isolated and found to be highly virulent for mice, were composed entirely of tough colonies forming mat surfaces and growing in clumps in broth; whereas, after a few subcultures on agar and in broth, there began to appear glossy, watery colonies, which were nonvirulent in the doses in which the mat type caused death.

Cultures composed of mat colonies were also encountered which failed to kill mice, but the potential virulence of which could be increased by passage through mice. The glossy colonies were highly stable and no virulence could be developed. Later, Todd and Lancefield[5] reported isolating the mat form of the hemolytic streptococcus from diseases in which the streptococcus was undoubtedly the causal agent, including scarlet fever, pneumonia and sinusitis.

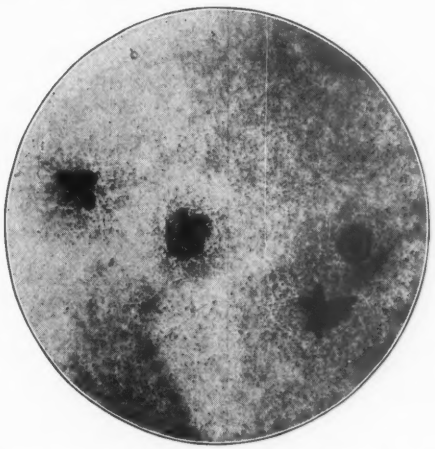

Fig. 1 (Case 1).—Rough (lobated) and smooth (transformed from rough) colonies; 7-day blood-agar; transmitted light. (×16.)

In opposition to Todd's results, Dutton[6] has made the observation that fatal streptococcic infections in human cases in-

4. Todd, E. W.: Brit. J. Exper. Path., 9:1 (Feb.) 1928.

5. Todd, E. W., and R. C. Lancefield: J. Exper. Med., 48:751 (Dec.) 1928.

6. Dutton, L. O.: J. Bacteriol., 16: 1 (July) 1928.

variably yielded S cultures, whereas infections running a middle clinical course usually showed R types of culture. Moreover, he reported that his R streptococci were avirulent for mice, but he did not give results on the S type. Although Dutton clearly described various S and R colony forms, he was not able to work out any definite sequence in the types; nor did he mention which kind of his several R types was encountered in the human infections.

more virulent than the R, while, in another strain, it was less virulent.

It is thus apparent that conflicting results on the dissociation of streptococci have been obtained, particularly where the relation of colony form to virulence was concerned. In view of this fact, it has seemed opportune to report certain recent observations on colony variation and virulence in three strains of greening (alpha type) streptococci, freshly isolated from the pulp canals of teeth.

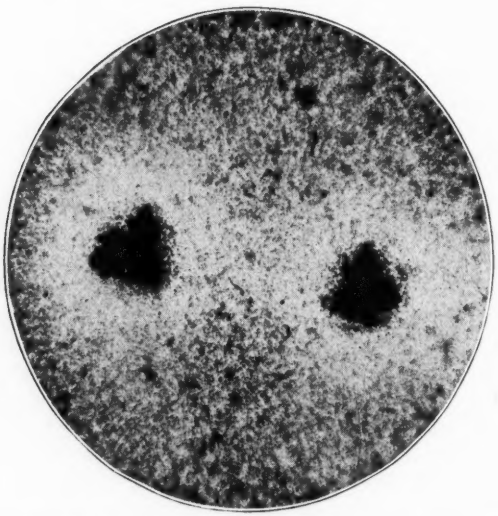

Fig. 2 (Case 1).—Rough (lobated) colonies; 14-day blood-agar; transmitted light. (×15.)

On the other hand, Andrewes[7] has stated that the R type of hemolytic streptococci is more virulent than the S, while Eagles[8] concludes that "colony appearance is not a reliable indication of virulence in hemolytic streptococci," since he found that the S of one strain was

7. Andrewes, F. W.: J. Pathol. & Bacteriol., 31:132, 1928.

8. Eagles, G. H.: Brit. J. Exper. Path., 9: 330, 1928.

EXPERIMENTAL WORK

Case 1.—A pulpless molar with filled root-canals was extracted from a man complaining of severe arthritic pains in the back. The surfaces of the roots were sterilized with alcohol and the apices snipped off into tubes of glucose-brain broth. No growth occurred until the third day, when a short-chained streptococcus appeared. Streaks made on blood-agar plates revealed two types of

streptococcus colonies: one round, soft, smooth, translucent, 1 mm. in diameter, easily removed with a platinum needle, and indifferent in its action on blood; the other, irregular in contour, smaller, dry, opaque and so adherent to the medium that it could not be removed without cutting out a piece of the underlying agar. This type showed a distinct greening of the blood, with the subsequent formation of a zone of hemolysis, characteristic of the alpha streptococcus. The smooth type contained small, weakly gram-positive diplococci. The rough, dry type was made up of larger gram-positive streptococci in short chains (6-12 elements). Both types showed a homogeneous clouding in brain broth.

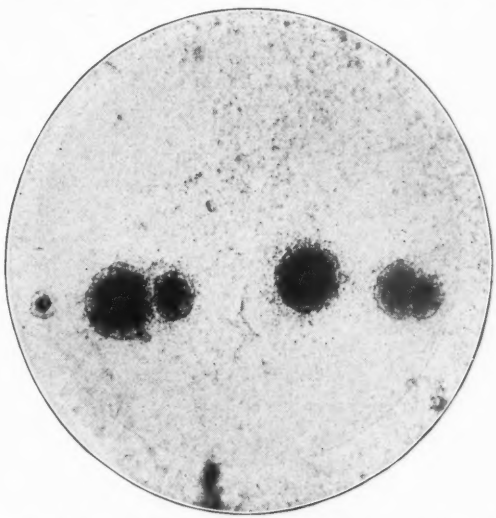

Fig. 3 (Case 1).—Smooth (transformed from rough) colonies; 14-day blood-agar. (×15.)

Young rabbits, weighing approximately 2.5 kg., were injected intravenously with 3 c.c. doses of (1) the original 3-day brain broth culture of mixed smooth and rough streptococci; (2) a 48-hour brain broth culture from one rough colony; and (3) a 48-hour brain broth culture from one smooth colony. The first rabbit showed a definite stiffness of the hind legs and pelvic region twenty-four hours after injection, the animal refusing to move unless forced, whereupon it often fell on one side. This condition became more marked, with continual loss in weight, up to the tenth day, when death occurred. Necropsy revealed heart, lung, gallbladder and kidney lesions, and an enormous distension of the bladder, which contained urine showing a high specific gravity and many leukocytes, but no albumin. The joints appeared normal. Both smooth and rough forms of streptococci were isolated from the heart blood, the heart vegetation and the lung. The kidney lesions and urine revealed only R colonies.

The second rabbit, injected with the pure rough culture, died in twenty-four hours, with an acute septicemia. Pure R cultures were isolated from the heart blood, lung, kidney and spleen. The third

rabbit, injected with the same amount of pure smooth culture, remained well and active during the eleven weeks that it was observed.

It may be noted here that it was a characteristic of the R colonies which composed the strains recovered from the animals to be even rougher and more irregular than the original rough strain injected. By the second or third day on blood-agar, these colonies appeared lobated, with the colony structure lying almost completely below the surface of the agar, although the surface was not broken during the streaking. Some of these colonies had a thin, transparent surface growth superimposed on the imbedded colony. These colonies were very striking and indicated that passage through animals had increased the rough character of the rough strain injected. (Figs. 1 and 2.)

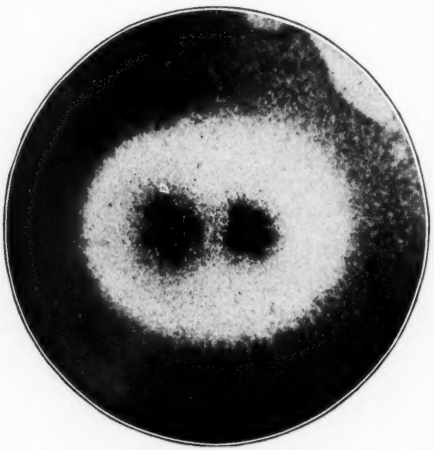

Fig. 4 (Case 2).—Rough (lobated) colonies, showing zones of fixation and hemolysis; 4-day blood-agar; transmitted light. (×15.)

The question now arose as to whether this smooth, indifferent streptococcus, apparently lacking in virulence, and the rough, green producing streptococcus, distinctly virulent, were two forms of one organism, or whether they were entirely different strains, possessing no interrelationship. This question was attacked in two ways: first, by an attempt to transform the S strain into the R, and, secondly, by transforming the R into the S. The first attempt, that is, to produce the S to R transformation, was unsuccessful by the simple methods used during the short period of study. Continued cultivation in brain broth, with frequent platings on blood-agar from both young and old cultures, failed to reveal anything but the smooth, indifferent colonies. The fermentative ability of this strain was unusual, since it attacked saccharose and inulin, but was negative to lactose, raffinose, mannite and salicin.

Success was attained in the attempted R to S transformation. A procedure involving alternate growth of the rough strain in brain broth and on blood-agar, similar to Cowan's method of obtaining rough cultures from smooth, was carried out. The smoothest colony present on the

blood-agar was always selected for inoculation into the next brain broth. The brain broth culture was then grown at 37 C. for forty-eight hours and again spread over a fresh blood-agar plate. After two such transfers, that is, on the third blood-agar plate, six relatively smooth colonies were detected among the rough.

These relatively smooth colonies were characterized by being somewhat larger (approximately 1 mm. in diameter) than the rough; round, with a regular contour and a smooth but dull surface. Some had colonies. Moreover, these relatively smooth colonies produced a distinct greening of the blood, another difference from the original, nongreening smooth culture. Microscopically, the colonies were composed of short-chain streptococci, resembling those of the rough strain. Growth in broth was homogeneous. When the purity and stability of these modified smooth colonies were tested by several consecutive transfers of single colonies to brain broth and again spreading on blood-agar, only the same type of colony was revealed.

Fig. 5 (Case 2).—Same colonies as shown in Figure 4; reflected light. (×16.)

a smooth central eminence, while others were flat. (Figs. 1 and 3.) Although these colonies developed on the surface of the agar and were nonadherent (thus differing from the rough), they were friable when touched with a straight needle, the friability becoming more marked as the colonies aged. This was an important difference from the soft, butyrous consistency of the original smooth strain, and, for this reason, they were not classed as definitely smooth

The important question now arose: Had the original rough and virulent form lost its virulence during its forced transformation to the modified smooth? In order to test this point, two rabbits were inoculated intravenously, each with 3 c.c. smooth forms (smooth flat and smooth of 48-hour brain broth cultures of these with central eminence). In no case was there any evidence of infection.

It thus appears that, while the original rough (colony) strain was distinctly viru-

lent, the relatively smooth type, into which it was transformed, was lacking in virulence. It was now necessary to ascertain whether the original rough stock had maintained its virulence during the period required for the forced transformation to the smooth; but here a difficulty was encountered.

During the time that the stability of the smooth dissociate strain was being tested, the rough strain, from which the smooth had been derived, was propagated through further alternate broth and agar transfers. On the fifth agar plate, the colonies

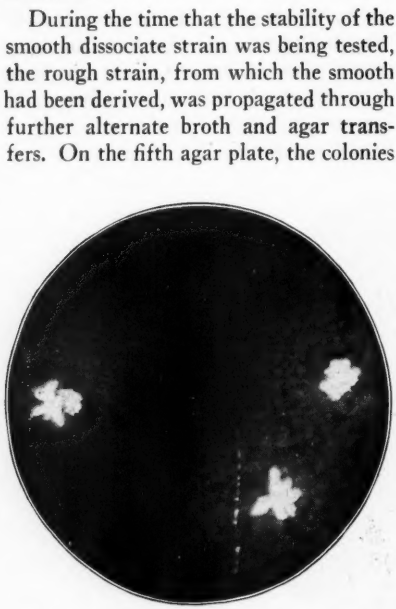

Fig. 6 (Case 3).—Rough colonies; 10-day chocolate-blood-agar; reflected light. (×10.)

appeared to be losing their roughness, and the next cultivation in broth brought about a complete transformation to the smooth-appearing type of colony described above. Subsequent transfers failed to reveal any colonies resembling the former rough ones. A further attempt was accordingly made to recover the original rough type.

The brain broth cultures from the fatal rabbit cases, originally composed of the rough, lobated form of colony, were reexamined, having been five weeks in the original tubes. These also were found to have gone over completely to the smooth form. A two weeks' blood-agar slant, inoculated from a rough colony before the culture became spontaneously transformed, revealed, when restreaked on blood-agar, both rough and smooth colonies, the rough being largely those of the surface variety originally encountered. Among these was detected one colony growing in the lobated formation under the surface of the agar. Agar to agar transfers of this lobated form continued to give a large proportion of the same type, but always mixed with a few of the surface rough and also some smooth colonies. Apparently, continued cultivation on blood-agar, with the omission of broth cultivation, served only partially to arrest the R to S transformation.

Although this rough culture was therefore not recovered in the pure form in which it originally existed, it was decided to test its virulence in this mixed state. Three cubic centimeters of a 48-hour brain broth culture, made from a lobated colony, were injected intravenously into a rabbit, and 0.1 and 0.2 c.c. intraperitoneally into two mice. No effect was observed in the rabbit. The mice remained well and were killed on the seventh day. Necropsy of the 0.1 c.c. mouse revealed severe congestion of the lungs and enlargement of the spleen, from which cultures were obtained of the smooth form of green producing streptococcus. The 0.2 c.c. mouse showed no abnormalities. It was discovered, from an examination of the blood-agar plate streaked with the injected culture, that, although the broth had been inoculated with a lobated colony, only relatively smooth colonies were present in it at the time it was injected. This incident demonstrates the desirability, in studies of this

sort, of a confirmatory test, performed at the time of inoculation, to reveal the colonial components of the broth inoculum.

Since it was thus apparent that the rough form of culture, as recovered, quickly reverted to the smooth in one passage through broth, an attempt was made to secure for injection saline suspensions of dense growths on blood-agar plates. One cubic centimeter of sterile physiologic sodium chlorid solution was added to the 48-hour growth on blood-agar, which was then rubbed with a sterile bent glass rod.

Further attempts to stabilize the rough strain to such an extent that passage through broth would not effect a transformation to the smooth type, resulted in a broth culture the confirmatory test for which revealed both lobated and smooth colonies in equal numbers. Three cubic centimeters of this 24-hour brain broth culture injected into a rabbit caused a progressive loss in weight and a mild arthritis. No marked virulence of the culture was demonstrated. Apparently, the original rough culture either was reduced in virulence by the presence of the smooth

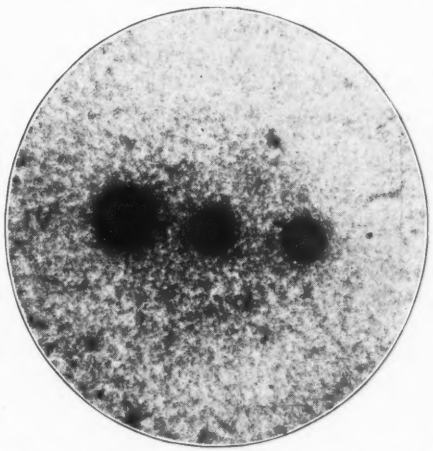

Fig. 7 (Case 3).—Smooth (transformed from rough) colonies; 7-day blood-agar; transmitted light. (×15.)

The difficulty experienced here was that it was practically impossible to detach the rough colonies from the agar. After a vigorous rubbing, the supernatant sodium chlorid solution remained almost clear, and the colonies were seen to be still intact on the agar. This thin suspension was nonvirulent for a rabbit and a mouse. Plates spread with the smooth culture growth easily gave a smooth, dense suspension, which was also nonvirulent for mouse and rabbit.

forms, or, although maintaining its rough colony form, had already begun to change to the nonvirulent S type.

Case 2.—A woman in fairly good health, complaining only of lassitude, had an upper bicuspid with a degenerating pulp carefully opened *in situ,* and the canal contents were inoculated in a tube of 0.1 per cent infusion agar to which had been added 0.2 per cent of glucose and 5 per cent of sterile ascitic fluid. In two days, there was a profuse growth of strep-

tococci in short chains, which, when streaked on blood-agar, gave only one type of colony, the distinctly lobated, rough, green producing (alpha) type, growing beneath the surface of the agar, and similar to the R form that was encountered in Case 1. (Figs. 4 and 5.) One colony was transferred to glucose-brain broth, and after twenty-four hours' incubation, a rabbit was inoculated intravenously with 3 c.c. At the same time, a control blood-agar plate was streaked with the broth culture. The animal was found dead sixteen hours later, and pure cultures of the same rough strain of streptococcus were recovered from the organs.

The blood plate made from the injected culture contained, among the rough colonies, many of the relatively smooth, but friable, green producing type seen in Case 1. This friability became less marked as the smooth strain was propagated from blood-agar to blood-agar, so that, within two weeks, smooth, flat, soft colonies were secured. Rough and smooth brain broth cultures (the rough and smooth characters being confirmed on blood-agar) were then injected into two rabbits. The rough culture rabbit was found dead fourteen hours later. The smooth culture rabbit remained well during the six weeks of observation. Mice were found not to be susceptible to the rough strain, as 0.8 c.c. injected intraperitoneally failed to cause death.

This rough, lobated strain appeared to be in a more stable form than that of Case 1, and although occasional smooth, nonvirulent colonies were given off, the rough colonies remained predominant, even in brain broth, for the two following months that the strain was observed. At the end of this time, the virulence for rabbits was still high.

Fermentation tests were the same for both rough and smooth types. Lactose, saccharose and raffinose were attacked; mannite, salicin and inulin were not attacked.

Case 3.—Three teeth were extracted from a woman with a history of repeated rheumatic attacks. A molar, with filled root-canals, was cultured in brain broth and gave a pure growth of the rough, lobated, greening colonies described above. (Fig. 6.) A rabbit injected with 3 c.c. of a 20-hour culture of the rough strain died in sixteen hours. A few smooth colonies, also greening, were observed on blood-agar plates after four transfers in brain broth, the smooth colonies being rounder, more glistening and softer than the smooth colonies of Cases 1 and 2. (Fig. 7.) These were nonvirulent for a rabbit injected as the one above. As in Case 1, the rough strain of Case 3, although retaining its rough, lobated character when plated from broth, appeared to have partially lost its virulence within six weeks after its isolation. A 3 c.c. injection at this time failed to cause death, although the animal lost 160 gm. in weight in three days. Another rabbit, injected with the same amount of smooth culture, gained 10 gm. in the three days and remained well.

The fermentative reactions of both rough and smooth types were the same as for those of Case 2.

SUMMARY AND CONCLUSIONS

This paper presents a study of three strains of green producing streptococcus (alpha type) isolated from three cases of root-canal infection.

In all cases, the R (rough) form of colony was the type isolated directly from the tooth, and, in all cases, this R type was transformed into the homologous S (smooth) type. In one strain, there was

observed a tendency for this transformation to occur rapidly and spontaneously in broth cultures. In the other two cases, the R type was more stable.

The rough and smooth forms described differ in certain respects from the rough and smooth forms of *S. **hemolyticus*** described by Cowan, and from the mat and glossy forms described by Todd.

The R forms carried the virulence of the strains for rabbits, while the S forms were nonvirulent. This is in accord with the reports of Todd and of Andrewes on hemolytic streptococci.

A natural colony variation is thus established among green producing streptococci from infected root canals; and the chief variants, R and S, are thus correlated with virulence and nonvirulence, respectively.

Although it is apparent that the R type carries the maximum virulence of the strain, some of the results obtained indicate that the physiologic change within the cell accompanying the R to S transformation (virulent to nonvirulent) may proceed more swiftly than the morphologic change in colony structure.

Although this work does not offer conclusive evidence that a higher virulence invariably characterizes the R type of the greening streptococcus, it at least demonstrates the importance, in further experimental work, of focusing attention on the various distinct forms in which an infecting organism may appear and produce its most harmful effects.

IMPACTED FOURTH MOLAR; DENTIGEROUS CYST: CASE REPORTS

By B. L. CARPENTER, D.D.S., Porterville, Calif.

CASE 1.—A woman, aged 34, complained of ringing in the ear. A roentgenogram revealed a mandibular fourth molar. On removal of the tooth, the ear trouble cleared up.

Fig. 1.—Impacted fourth molar.

CASE 2.—A boy, aged 12, came in after suffering two days with a constantly increasing swelling of the jaw. A roentgenogram revealed a dentigerous cyst. Lancing relieved the swelling somewhat. One week later, the cyst was removed under local anesthesia. The cavity was loosely packed. The following day, it was repacked. There was no soreness or swelling. An ivory-like tip of the cyst pointed downward; the body of the cyst was calcified tissue, and the root of the imbedded tooth extended upward from the body of the cyst. The growth extended into the nasal and maxillary sinuses.

Fig. 2.—Dentigerous cyst.

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Editorials

THE DENVER MEETING

The Seventy-Second Annual Session of the American Dental Association is a matter of history. It convened at Denver, Colo., July 21-25, 1930, and in many ways it registered real progress. The attendance was probably not quite so large as on some previous occasions owing to several circumstances, but the interest throughout was steadily maintained and the net result was quite satisfactory.

The widespread industrial depression undoubtedly had something to do with limiting the attendance, and the intense hot wave which swept the country just before the meeting in all probability prevented many from going to Denver who otherwise would have done so. The latest data on the attendance show an aggregate of a little more than 5,000, and the hotel facilities were taxed to their utmost to take care of the members. The report of the hotels was to the effect that our Association brought a fuller quota of estimated attendance to Denver than any other convention that had met

there this year. The Denver people and particularly the Local Arrangements Committee did their best to see that everything possible was done for the comfort and welfare of the visitors, and the Association is under deep obligation to them.

The problem of adequately caring for our annual meeting with all of its ramifications is becoming a progressively more serious one, and the House of Delegates should consider carefully the hotel and hall facilities of a city before voting to accept an invitation to hold the meeting at that place. The fact must be recognized that there are relatively few cities that can acceptably accommodate the American Dental Association, and it is becoming more and more important to give careful consideration to this matter. The welfare of the Association is paramount and should dominate the decision rather than the impulsive desire to encourage any given section of the country by holding the meeting in that vicinity.

One of the hardest tasks performed at the Denver meeting was the work of the Budget and Finance Committee. They were confronted with a situation that was exceedingly difficult. It was found on comparing the aggregate of the various budgets with the estimated income for the ensuing year that the former exceeded the latter by about $46,000 and manifestly some rather drastic trimming of the askings had to be done. This is always an onerous task for any committee, and, in the present instance, the Association is deeply indebted to its 1930 committee for the earnestness, the courage and the fairness with which it fulfilled its function. It is not an altogether unfortunate thing that certain of our activities will have to be conducted more economically than in the past—in short, the present stringency may turn out to be a blessing.

From all accounts, the scientific program of the meeting, consisting of addresses, papers and clinics, was of a very high order and was well calculated to maintain the best traditions of our organization. The printed proceedings will represent a very accurate cross-section of contemporaneous dental thought, and we can promise our readers much interesting material during the coming year.

A difficulty that had been brewing for some time between the American Dental Trade Association and the American Dental Association culminated in the refusal of the former to exhibit at the 1930 meeting. This decision led to the following resolution by the Board of Trustees and House of Delegates:

Resolved: That the Business Manager be directed not to sell exhibit space to any trade organization as such. This is understood to mean that the Business Manager is not prevented from discussing space with or selling it to manufacturers, firms or individuals.

This resolution was adopted.

At the Denver meeting, there were seventy-two commercial exhibitors, and they were frank in their expression of satisfaction at the results. There was the best possible fellowship between the exhibitors and the Association.

A definite move was made toward purchasing a home for the American Dental Association. It was felt that the present plan of paying rent was not economically sound and that the sooner the Association secured a home of its own, the better. We shall allude to this matter in greater detail at a later time.

Drs. Georges Villain, of Paris, and Emile Huet, of Brussels, appeared before the convention on behalf of the International Dental Federation and the Eighth International Dental Congress to be held in Paris, Aug. 3-8, 1931. The details of this Congress will be presented to the American dental profession from time to time, and meanwhile as many of our members as can possibly do so should plan to attend.

The election of officers resulted as follows:

President Elect, Martin Dewey, New York City; President, Robert Todd Oliver, Philadelphia; Vice Presidents, Max Giesecke, Denver, Colo., Rush P. Abbott, West Point, Miss., and E. W. Elmen, Sioux Falls, S. D.; Secretary, Harry B. Pinney, Chicago, Ill.; Treasurer, R. H. Volland, Iowa City, Iowa.

Memphis was selected for the next place of meeting, and while the exact date is not set at the present writing, it is likely to be rather late in the autumn to enable those who go to Europe for

the Congress to reach home in ample time for the A. D. A. meeting.

In summing up the 1930 meeting at Denver, it must go on record as a most successful one. There was a fine spirit of cooperation on the part of everyone, and very much constructive work was accomplished. The general meetings were very interesting, and the section meetings more than ordinarily successful. The housing of the sections was admirable, with separate rooms and walls sufficiently thick to prevent the admission of sounds from the outside. This was a great improvement over some previous meetings, and it is a matter that should concern those who arrange for subsequent sessions.

The President, Dr. Bogle, conducted the meeting with signal ability, and he is to be congratulated on the complete success of the Seventy-Second Annual Session. It is not too early to begin earnest preparation for the 1931 Session, to the end that our Association may register steady advance in each succeeding year.

DO NOT OVERREACH

To aim high is a virtue: to overreach is folly. Estimating your capacity is a science: to know when to stop is an art. To reach too high and slip is often to fall back beyond the starting place. The time honored saying, "Look before you leap," is as logical today as it ever was, and the principle applies to all the ventures and enterprises of life. To be able to judge distance is as essential in the ordinary problems of the day as it is in dodging an automobile. To know the limit of your capacity, and profit by it, is to conserve your interest and play safe in the game of life. This does not mean that you are to be too timid to attempt to do the thing that needs to be done. Do it resolutely, but do not do it blindly and without judgment. Most of the things we attempt may be sufficiently estimated in advance so that we are able to gain a proper perspective before we start, and thus know when to stop. Do everything that is to be done, but don't overdo it.

COUNCIL ON DENTAL THERAPEUTICS

THE SHERMAN L. DAVIS TREATMENT: CAPEROID, VICODOL, SYRUP OF ALFEMINE

After this report was adopted by the Council, Sherman L. Davis submitted a number of "case histories," which the Council considered. The "case histories" were of such an uncritical nature that they could not be considered in any way as scientific evidence. There was nothing in the material submitted to cause a revision of the following report. The Council therefore confirmed the adoption of the report and authorized its publication.

SAMUEL M. GORDON, *Secretary.*

MANY inquiries from physicians and dentists have come to the Council on Dental Therapeutics regarding the activities of Sherman L. Davis; and the preparations for the "correction" of tooth and bone disorders put out under his direction. Inquiries were addressed both to Sherman L. Davis and to the dean of the Indiana University School of Dentistry for information concerning the composition of the products in the Sherman L. Davis Treatment and the department of Nutritional Research of that school. Neither Dr. Davis nor the dean have supplied information of a satisfactory character to date.[1] Hence, the Council deems a report on Sherman L. Davis and the products to be in the interest of the public and the dental profession.

SHERMAN L. DAVIS, M.D., A.B., A.M., PH.D.

The preparations recommended in the Sherman L. Davis method appear to be actively exploited in connection with the lectures which are delivered by Dr. Davis. It is pertinent, therefore, to inquire into the professional qualifications and scientific attainments of Sherman L. Davis and of his affiliation with the School of Dentistry of one of America's foremost universities. Advertising material carries the advice that Dr. Davis is "a recognized authority on dental nutrition" and "for the past fifteen years, he has studied the factors involved in the prevention of dental caries." It is necessary to consider Sherman L. Davis because the whole propaganda of these products intimately centers around the personality of Sherman L. Davis and is indeed inseparable from him.

According to our records, Sherman L. Davis received the degrees of A.B. and A.M. from Indiana University in 1891 and 1892 and the degree of Ph.D. from the University of Marburg (Germany) in 1896. For some years, he was professor of chemistry at Indiana University School of Liberal Arts. In 1926, he was transferred from the school of liberal arts to the dental school, where he is now professor of chemistry and director of nutritional research.

1. After this report was adopted by the Council, the dean of the Indiana University Dental School informed the Council of the resignation of Sherman L. Davis from Indiana University.

During the past few years, Dr. Davis has been doing a great deal of lecturing on nutrition before dental societies. A survey of *Chemical Abstracts* as far back as 1907, "Cumulative Index Medicus" and the "Index of Dental Literature" indicates that Sherman L. Davis has contributed nothing to chemical, medical or dental literature up to 1927, a period of about twenty years. Apparently, the first paper under his name appears in the *Pacific Dental Gazette,* November, 1927. No other reference was found until February, 1929. The *Journal of Dental Research* carries a report of an address delivered by Dr. Davis before the New York Academy of Dentistry, in January, 1928.[2]

These papers deal in generalities and do not give data of an original research nature nor do they furnish references to authors quoted. In this paper, Dr. Davis makes many statements that do not indicate a very accurate knowledge of biochemistry and theorizes without an adequate basis for doing so. As an example of some of these statements, the following may be quoted: "From the amino-acids the epithelial cells of the intestines synthesize two proteins, serum albumen, and serum globulin, which are absorbed into the blood. . . ." Nearly twenty years ago, Folin, Van Slyke and Abel[3] showed by different methods that the amino-acids are absorbed by the blood, rendering untenable the foregoing theory.

In the course of the discussion on the above-mentioned paper, Dr. Davis is quoted as saying, "The cod liver oil we use has to be certified by a government agent. We pay twelve dollars a barrel for that service." As far as this Council is aware, there is no government agency that examines cod liver oil for manufacturers.[4]

Other inaccurate statements may be quoted.

The subject matter of this paper apparently has been widely reprinted and, with a few minor exceptions, appears to be Dr. Davis' contribution to exact scientific literature. Nowhere in subsequent issues of the *Journal of Dental Research* does a correction of the misstatements referred to appear. From the lack of references to scientific contributions by Sherman L. Davis, one is justified in drawing the conclusion that Dr. Davis' contributions do not justify for him the designation "expert" on nutrition.[5]

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2. The dean of the Indiana University School of Dentistry, in a communication which was referred to the Council, denies that Dr. Davis contributed an article to the Journal of Dental Research. He stated that the address was printed from stenographic notes.

3. Folin, O., and Denis, W.: J. Biol. Chem., 11:87, 1912; Van Slyke, D.D., and Myer, G. M.: J. Biol. Chem., 16:197, 1913-1914; Abel, J. J., Rowntree, L. G., and Turner, B. B.; J. Pharmacol. and Exper. Therap., 5:611, 1913-1914.

4. The Assistant Chief of the Food, Drug and Insecticide Administration informs the Council: "Receipt is acknowledged of your letter of March 13 in regard to cod liver oil certified by a government agent. As far as we are aware, there is no branch of the government which performs such a service."

5. The following papers have been found in the literature: Davis, S. L.: Methods of Combating General Malnutrition of Significance to Dental Teachers, Pacific Dent. Gaz., 35:661-665 (Nov.) 1927. Sherman L. Davis: The Relation of Nutrition to General Immunity, J. Dent. Res., 9:11-28 (Feb.) 1929. (Address before N. Y. Academy of Dentistry, Jan. 30, 1928.) Sherman L. Davis: Nutritional Factors which Influence Mouth Tissues, Am. Dent. Surgeon, 50:55-57 (Feb.) 1930. (Read before the American Academy of Restorative Dentistry, Washington, D. C., October, 1929.) Dental Survey, December, 1929, et seq. Miscellaneous papers in Dental Digest, June, July and August, 1929. Nutritional Procedure for Arresting Caries: Report of Cases, J. A. D. A., 17:335 (Feb.) 1930.

The "contributions" of Dr. Davis to dental science and nutritional chemistry are mainly in the form of lectures. In none of the articles quoted does there appear a record of his laboratory and clinical experiences in such manner that they may be checked or verified by investigators in biochemistry, medicine and dentistry. On this depends the crucial test of therapeutic promise.

Sherman L. Davis does not appear to be a member of the American Chemical Society, the American Society of Biological Chemists, the American Federation of Societies for Experimental Biology and Medicine, the Indiana Academy of Science or the American Association for the Advancement of Science. His name does not appear in the latest edition of "American Men of Science" or in the "American Medical Directory." Although the title M.D. is used after his name, there does not appear a denial of this by Dr. Davis.

It is stated that Dr. Davis collaborated with Howe of Harvard and with Drain of the University of Iowa. The Council's files contain denials from both Dr. Howe and Dr. Drain that Dr. Davis has collaborated with them.

In connection with the exploitation of the products in the Sherman L. Davis Treatment, there is being issued as "Sales Talk" an article from which the following is quoted: "Having devoted a great amount of time to lecture tours over the country, the question has constantly arisen as to where his products can be procured." It seems to be easier to secure evidence on the lectures than on the fundamental scientific work upon which they should have been based.

THE PRODUCTS IN THE SHERMAN L. DAVIS TREATMENT

The preparations in the Sherman L. Davis Treatment are four in number: 1. Syrup of Alfemine. 2. Caperoid tablets. 3. Vicodol. 4. Vicaperol capsules.

In view of the fact that the composition of these drugs and methods of assay for these preparations are not given clear and intelligible expression, a communication was addressed to Dr. Davis requesting statements of the qualitative and quantitative composition; and whether or not these products were accepted by the Council on Pharmacy and Chemistry of the American Medical Association for inclusion in "New and Nonofficial Remedies." (This was before the Rules of this Council were published.) Dr. Davis replied that formulas were given on the labels; and that they had not been submitted to the Council on Pharmacy and Chemistry because "they are not drugs at all but foods intended to reinforce a diet that is likely deficient in several respects," and that the communication was being forwarded to the Rochester Laboratories, Inc., Rochester, Minn.,[6] for detailed answer." (It is hardly necessary to remind dentists that a number of "medicinal foods" are listed in New and Nonofficial Remedies.)

In view of this reply, which appeared to be a defensive gesture, Dr. Davis was then asked if these preparations were submitted to the Committee on Foods of the American Medical Association. Dr. Davis did not answer the question directly.

Later, Dr. Davis was firmly advised that the questions in the earlier correspondence were not satisfactorily answered, and he was invited to submit his products and evidence on which they were based to the Council. To date (June 14, 1930) Dr.

6. The Sherman L. Davis products are exploited by the Ucoline Products Co., Chicago, Ill. To date, no information has been received from the Rochester Laboratories, Inc.

Davis has not availed himself of the opportunity of presenting his evidence to the Council, whereby it might be considered on its scientific basis by this body working wholly in the interests of the dental profession and the public.

Syrup of Alfemine. — According to the label Syrup of Alfemine contains "Pyrrol-Vitamins-Mineral Salts." Elsewhere, it is stated to present "a ferric salt in combination with pyrrol nucleus of the hemoglobin molecule," whatever that may mean. Nowhere on the label or in the advertising does an honest quantitative statement of the composition appear. The nature of the vitamins and the mineral salts is not stated. As is well known, these expressions are inclusive ones, and hence are not such that the profession can consider seriously. In view of the enormous amount of work which has been done by pharmacologists and others on iron compounds, both simple and complex, it appears unlikely that Dr. Davis has done any more than coin a proprietary name for a preparation which supplied iron. Pharmacologists are aware that there is no sharp line of distinction between the natural complex iron compounds and the artificially produced ones, nor is there any good evidence that they differ in therapeutic action. The use of iron and its compounds in the treatment of anemia has long been recognized and for this purpose the ferrous salts are usually preferred to the ferric salts. Until Dr. Davis furnishes "honest" information concerning the composition, this preparation may be rejected in favor of the many available nonproprietary iron preparations.

Dr. Davis has not published adequate evidence to support his contentions that the administration of the "pyrrol nucleus of the hemoglobin molecule" has been shown necessary in the treatment of nutritional anemia. Apparently, the ordinary diet contains enough iron to prevent anemia in most cases.

Caperoid Tablets.—According to the statements on the principal label, Caperoid tablets are "Calcium-Phosphorus-Parathyroid." Advertising matter states "the clinical efficiency of Caperoid Tablets depends on the following factors: (a) the formula presents calcium and phosphorus in the definite proportions in which they are found present in the bone and dentin and (b) the presence of parathyroid gland substance which supplies an essential factor for proper calcium assimilation and fixation."

Is calcium present as phosphate, metaphosphate, pyrophosphate, or one of the other calcium compounds containing phosphorus? The information that Professor Davis supplied on the label and advertising does not permit an accurate statement. Microscopic and chemical examination indicates that the tablet is principally composed of tricalcium phosphate.

The calcium content of a diet is easily increased by drinking milk, or by diluting table salt with an equal amount of chalk and, as is also known, other inorganic calcium salts may supply the calcium needs. From the vast amount of information concerning the utilization of calcium and phosphorus available to pharmacologists and biochemists, there is no adequate evidence that calcium and phosphorus in the definite proportions in which they are found present in the bone and dentin are more readily absorbed than other compounds. If the dentist wishes to use tricalcium phosphate, suitable brands are available in most drug stores at reasonable cost. It is significant to note again that no suitable evidence has been published by Dr. Davis regarding the usefulness of his products. It would take many pages to discuss the

statements emanating from Sherman L. Davis, for such a discussion must be strictly governed by the weight of available evidence, whereas Dr. Davis does not limit himself, frequently making statements for or against which there is no evidence.

The assertion that the oral administration of parathyroid gland substance in combination with calcium and phosphorus will bring about proper conditions for calcification of teeth and bone is contrary to the mass of accumulated evidence on the oral administration of parathyroid. The following experiment as to the ineffectiveness of parathyroid when taken by mouth may be quoted: "Desiccated parathyroid glands given to dogs in doses from 1 gram (15 grains) to 45 grams (675 grains) had no effect on the blood calcium level. Neither has this preparation on oral administration any prophylactic or therapeutic effect on parathyroid deficiency." It is conceivable that in an abnormal alimentary tract, as during marked hyperemia of enteritis, in ulcerations, etc., absorption and systemic actions of parathyroid might occur, especially after prolonged administration. This, of course, would be unpredictable, but the possibility of harm is present since parathyroid is very potent in the system.

On the other hand, the effects of properly prepared and standardized parathyroid gland substances are extremely potent when administered intramuscularly or subcutaneously. The harmful effects of systemic action exist in the withdrawal of calcium from the bones, which in time become porous and fragile. In dentistry, therefore, the prolonged administration of parathyroid might result in loosening of the teeth owing to dissolution and rarefaction of the jaw bone. On this account, and because of the danger of hypercalcemia, which is easily induced by overdosage with an active preparation, it is imperative that clinical use of the material should be carefully controlled by accurate determination of the serum calcium. Another effect of the increased calcium after parathyroid administration is the thickening of the blood (increased viscosity), which tends to embarrass the heart and cause collapse.

To ascribe to the oral administration of parathyroid preparations improvement in conditions which are not definitely known to depend on parathyroid disease, or deficiency, is illogical and misleading. Until Dr. Davis can supply adequate evidence to support his sweeping statements, they may be considered to be in the realm of fancy and not fact. In view of the fact that the real usefulness of parathyroid has not yet been established and that there is great danger of hypercalcemia and its effects when improperly used, parathyroid has no place in preparations of the type exploited by Dr. Davis, which for ordinary and healthy individuals is probably inert when taken by mouth.

Vicodol.—This is supplied as part of the treatment "to complete the picture from a clinical standpoint . . . it is necessary to supply certain vitamins which are said to act on the centers of calcification." These are said to be "supplied in Vicodol, a specially blended cod liver oil, rich in vitamins A, D and E."

No standards of the antirachitic vitamin (vitamin D) or the anti-ophthalmic vitamin (vitamin A) content of Vicodol have appeared in the published writings of Dr. Davis, or in the advertising matter exploiting the preparations. It has not yet been established that vitamin E (the antisterility factor) is related to the problem of calcification or tooth formation. In view of the lack of exact statements concern-

ing the potency and lack of evidence for the advantages of this cod liver oil preparation over those brands which are accepted by competent bodies on the basis of scientific evidence, they appear to present no advantage over readily obtainable brands of cod liver oil.[7]

Vicaperol Capsules.—Vicaperol capsules are said to be soft gelatin capsules containing a combination of Caperoid tablets and Vicodol, with the calcium and phosphorus of the Caperoid tablets suspended in Vicodol. The remarks made concerning Vicodol and Caperoid tablets are applicable to this product.

No one would seriously disagree with the contention that the intelligent application of dietary principles may be of prophylactic and possibly curative value in the prevention of certain disorders. The evidence at hand does not justify sweeping statements concerning the effect of diet on tooth formation and tooth disorder. It has not been definitely decided which conditions are responsible for these functions. The evidence at hand does indicate that the intelligent application of foods containing the proper amount of mineral substances and certain accessory factors may possess prophylactic and possibly curative effects in this regard. The situation, however, is not so definite as Sherman Davis would have it appear.

It is not without interest to note that the directions of the Sherman L. Davis Treatment suggest, in a general way, dietary measures. The information supplied by Dr. Davis does not go beyond that already known, for the most fundamental articles of the diet suggested are fruit juices, vegetables, salads and milk. Indeed, reports have appeared from time to time indicating that dental caries may be controlled by the use of diet alone. Recently, Drain, Boyd and co-workers[8] have reported extensively on their work in the prevention of dental caries. The following statements by these workers are not without interest.

> It is worthy of special note that it has not been necessary to use mineral mixtures such as are being exploited as therapeutic dietary accessories to supplement the mineral content of these diets. Apparently the essential minerals have been supplied in adequate amounts by the use of menus which were simple in nature and readily obtainable.

Progressive dentists will await carefully controlled evidence before committing themselves to the use of preparations which are marketed in noninforming terms of composition and under exaggerated and unwarranted therapeutic claims. The exploitation of a presumed reputation of a teacher of chemistry and of a publicly supported university in connection with such preparations is a somewhat unusual scheme in the practice of either medicine or dentistry.

The contention of the dean of the Indiana Dental School that the Sherman L. Davis products are in the same category as insulin, viosterol and liver extract need not be seriously considered. These products were licensed for manufacture only after extensive publication of scientific evidence and acceptance by recognized bodies. The Sherman L. Davis preparations are exploited in a crude manner, before the necessary scientific data were made available to the profession, and even on invitation to submit information, it is withheld. The claims that profits from the sale of these

7. The Council expects very shortly to publish a list of acceptable brands of vitamin tested cod liver oils.

8. Boyd, J. D.; Drain, C. L., and Nelson, M. V.: Am. J. Dis. Child., 38:721 (Oct.) 1929; Boyd, J. D., and Drain, C. L.: J. A. M. A., 90:1867 (June 9) 1928

proprietaries are to be used for the furtherance of research cannot be used as a mitigating argument. When Dr. Davis will submit the necessary scientific data to the profession, his claims may be more scientifically considered. At the moment, the publication of these statements is due the profession.

Furthermore, the dentist who has the interest of his patients at heart, both professionally and financially, will not lend his name to a product of uncertain composition and uncertain action, particularly when he has readily available milk, oranges, and accepted brands of cod liver oil, in addition to many other items needed for a satisfactory diet. The Council wishes to remind readers that sound therapeutic knowledge originates in the laboratory and clinic and not on the lecture platform.

COMMENT OF DR. DAVIS

Indianapolis, Indiana,
July 31, 1930.

Dr. C. N. Johnson,
Chicago, Illinois.

Dear Dr. Johnson:

I have examined the report of the Council on Dental Therapeutics on the merits of the preparations we use with which to supplement our prescribed diet in arresting caries, hypersensitiveness, etc.

The council seems to think that these preparations (i.e. Alfemine, Caperoid and Vicodol) are the only factors we emphasize. As a matter of fact they are only a small part of the more comprehensive management.

I can find in this report no statement that the council has determined either their composition or their therapeutical value. Some time ago the council was invited to assist in making such tests but no response to the invitation was received. A number of case reports from dentists were submitted which confirm our findings that caries and hypersensitiveness can be arrested. These reports were not considered because "they were of such an uncritical nature that they could be considered in any way as scientific evidence." We have always assumed that an experienced dentist could determine when hypersensitiveness ceased and caries was arrested.

If the council wishes more detailed records, they may be found on file at Indiana University Dental School. These records include for each patient—

1. A complete physical examination by a competent physician. If conditions are found which require medical care the patient is referred back to his own physician for treatment.
2. Blood, urine and salivary analysis. The analysis of urine and saliva are made weekly. The blood analysis once a month.
3. Bacterial cultures of the mouth are made fortnightly.
4. The patient follows a prescribed diet, supplemented with mineral reinforcement if necessary.
5. The tooth structures are charted when the patient enrolls in the clinic, and are checked each month thereafter.

A partial report of this year's work is appended.

Group I—

48 cases—four new cavities developed during the first month of treatment. None after that time until discharged June 10th. 100 per cent cooperation was had with these patients. Time—seven months.

Group II—

Seventy-five children from 3½ to 17 years were treated as outlined. After four weeks and until completion of the test, one new cavity was reported. After the fourth week on this balance (Dec. 15) until June 15th, the house physician was not called once for illness.

Group III—

One hundred and sixty cases conducted by dentists.

New cavities—first month—12; second month—3; third month, etc., none reported.

Group IV—

The report from West Palm Beach Children's clinic is not yet tabulated.

I may say that we are also making quantitative analysis of teeth from children one tooth extracted before and one tooth after a five months' treatment. Progress is slow in this field as material is difficult to obtain. The results will be reported in due time.

If there are any other factors in studying this problem we should be grateful to the council on Dental Therapeutics if it will call our attention to them.

In a communication from the council May 2, the expression, "which as you know is an unbiased body working wholly in the interest of dentistry" is used. I leave the interpretation of this statement, (as illuminated by its report) to the judgment of the splendid gentlemen who make up the rank and file of the dental profession.

The council evidently considered it much less effort to criticise us than to determine with us the merits of our management. Meanwhile caries is rampant, and the children pay the price of obstrustive criticism.

I call attention to some points which seem important to the council.

1. "Have not submitted the quantitative composition of the supplementary materials—i.e., Alfemine, caperoid, and vicodol." I wish to point out that I have no interest financial or otherwise in these materials—they were disposed of some two years ago (gratis) as is a matter of record known to the council. It would be in point if the council should take up the matter of the composition with the interested parties.

2. The council makes much of a statement made by me some three years ago, that the oil was assayed by the government. This is an error. It was assayed by Professor Poulson of the University of Oslo, I have his certificate on file. This is ancient history since I have purchased no cod liver oil for three years.

3. They say that I claim to have collaborated with Drs. Howe and Drain. I have never made such a statement. Dean Miner of Harvard made some case reports to us. Dr. Drain was sent materials, case records, etc., at his request but to date has made no report.

4. The council offers criticism that the details of our work have not been published. They will be published in full when we consider the work completed—not sooner.

5. The council has evidently expended considerable energy in trying to prove (from stenographic reports) that some of my statements were inaccurate. No doubt of it. If I were 100 per cent accurate I would not be wasting my time on this report. I wish to point out that however gross and unscientific I may have been, it will not compare in this respect with this report of the council, in respect to the therapeutical values of Alfemine, Caperoid and Vicodol.

6. Sherman L. Davis (M.D., A.B., A.M., Ph.D.), I have never claimed an M.D. degree. I corrected this on the only occasion it appeared to my knowledge, by saying that I am neither an M.D. nor a D.D.S. I observe that some members of the Council on Dental Therapeutics work under similar restrictions.

SHERMAN DAVIS.

[Editorial Note: In the regular procedure, Dr. Davis' rejoinder would go to each member of the Council on Dental Therapeutics before publication, but this was found impracticable for lack of time. The reason that it is published without submission to the Council is the earnest desire to present both sides of this question at the earliest moment, so that no charge of unfairness can justifiably be made against anyone. It is not intended hereafter that comments of this character be published without first submitting them to the Council. The comment of Dr. Davis is published precisely as it was furnished by him.]

"ACCEPTED BY THE COUNCIL ON DENTAL THERAPEUTICS"

The publication of the following report is authorized by the Council.

SAMUEL M. GORDON, *Secretary.*

At the meeting of the Council, May 16 and 17, 1930, the question of the use of various phrases to denote acceptance of products, either for therapeutic or oral hygiene use, by the Council was discussed.

The use of a phrase to denote acceptance of preparations for therapeutic use is relatively simple, as these products will be advertised solely to dentists. The use of a phrase to signify acceptance of products sold directly to the public, such as dentifrice and mouth washes, is made complex by the nature of dentifrice advertising of recent times.

The advisability of adopting a seal to denote the Council's acceptance of a product or to consent to the statement "This product is acceptable to the Council on Dental Therapeutics of the American Dental Association" was discussed. In view of the short time that the Council has been functioning, the Council deems it wise to hold the adoption of a seal in abeyance until more experience is gained in the acceptance of certain classes of products—notably dentifrices. For the present, the Council will permit advertisers of dentifrices accepted for inclusion in "Accepted Nonofficial Dental Remedies" to state, "This product is acceptable to the Council on Dental Therapeutics of the American Dental Association," as long as the preparation is acceptable. In the event that acceptance is rescinded, the manufacturer agrees to discontinue the use of such a phrase, six months after notification of such action.

For the reason already stated, the Council deems it wise not to permit the use of such phrases as "This advertising is acceptable to the Council," as it holds that dentifrice advertising in general should be extensively modified along more rational lines. The Council will consider the feasibility of accepting public advertising, with the subsequent use of a suitable phrase, when dentifrice advertising is altered to follow more conservative and rational lines. The Council maintains it to be its duty to judge advertising in the consideration of particular products. The Council suggests that advertisers limit their advertising statements to the only demonstrable effect of dentifrices, namely, that the sole function of a dentifrice is to aid in keeping the teeth clean.

BUREAU OF DENTAL HEALTH EDUCATION

DENTISTRY'S PLACE IN OUR PUBLIC SCHOOLS*

By A. R. McDOWELL,† D.D.S., San Francisco, Calif.

BY way of introducing the subject, let us recall the statement of Disraeli:

Public health is the foundation upon which rests the happiness of the people and the welfare of the state.

Public health should be the concern of every citizen, and I am sure that every one of you is vitally interested in this great problem. It is a great problem, so great that, at the present time, there is a survey being made on the Cost of Medical Care which includes all forms of health service in the United States.

I quote from one of its early reports, just released: "Each year, disease and defectiveness levy a large toll of suffering, inefficiency and death upon the people of the United States." Perhaps you will be astonished to know that there are "approximately 1,500,000 persons in the United States estimated to be employed in connection with the care and prevention of illness," and that "this army is greater than the population of a city as large as Detroit." The report states, "In recent years, the importance of dentistry and oral hygiene to general health has been more widely recognized." The practice of medicine and dentistry have a common objective, namely, a healthier, happier people; and with that in mind, let us now devote our earnest attention to our subject. Our people are beginning to give more consideration to the growing importance of dental service in relation to general health problems. Henry S. Pritchett, president of the Carnegie Foundation for the Advancement of Teaching, in commenting on the relative importance of the practice of medicine and dentistry, in his annual report to the foundation for 1923, said; "The practice of medicine and the practice of dentistry are co-ordinate divisions of health service. They are like trees that have sprouted spontaneously from an old stump, the stump having long since disappeared—trees alike in kind and closely similar in appearance, growing somewhat divergently from the same roots in a common soil, through the same air of freedom and individual opportunity, in the same light, toward the sky. Dentistry can no longer be accepted as mere tooth technology. Its function has risen to the dignity and importance of scientific health service."

The care of the teeth is important, how important people are realizing more and more each day, and I deem this an auspicious occasion when we can come together and discuss perhaps a forward-looking plan for the dental welfare of the children of Merced County.

*Read before the Merced County Teachers Institute, Merced, Calif., Nov. 25, 1929.

†Chairman, Mouth Hygiene and Public Instruction Committee, California State Dental Association.

You have assembled this week to commune with one another, to discuss and hear discussed problems of teaching that are confronting you in your daily work. You are primarily interested in children; you have an ideal, an ideal of molding the minds and training the bodies of the boys and girls under your care so that they will be prepared to meet the demands that life will make of them after leaving school.

Fig. 1.—Dental unit of the San Joaquin Local Health District, San Joaquin County, Calif.

You are interested in the children committed to your care because teacher training imposes such a responsibility on you, and, further, the humanitarian instinct of a teacher ever present inspires you to do all that you can for the welfare of those entrusted to your direction. Yours is a great and noble profession patiently builded and perfected through struggles led by great and wise and heroic men and women. Your inspiration and your ideals have come down to you through the years from such educational leaders as Horace Mann, Henry Barnard, J. P. Wickersham, John Swett and others who have gained national distinction as founders and directors of state systems of public instruction.

What a heritage, my colleagues, is yours to be entrusted with the training of the youth of this county! In these days of so much discussion over national defense, consider Burke who said, "Education is the chief defense of nations"; and Horace Mann, "School-houses are the republican line of fortification."

The public school is an educational institution dedicated to the youth of America, and every method used in connection with its functioning should be

constructive, helping the child to discover and develop his highest possibilities.[1]

In the days of the "Hoosier Schoolmaster," the chief aim of the public school was to develop a strong mind and instruction consisted largely of drilling in the three "R's." Today, we are not content with having our children just read about life alone: the curriculum now includes physical education and other subjects designed to teach them how to live life—to live it fully, nobly and well, and includes the broader concept of life, that of developing a sound mind in a strong, well-developed body.

Health is the very cornerstone of life. Without good health, there can be no enjoyment, no happiness, and impaired mental and physical development is the usual result. Parents, teachers, children, public health nurses, social service workers and others interested in child welfare are working unitedly toward the goal of perfect health for every child.

We have come to the time when almost every organization, institution and industry is emphasizing health. So important is health in the opinion of the management of many of our larger industries that their employes are provided with medical, dental, nursing and hospital service in some form. In a "Report on Industrial Dentistry," E. L. Pettibone, of Cleveland, has published a partial list of eighty-nine industrial and mercantile organizations which have established dental service for their workers.

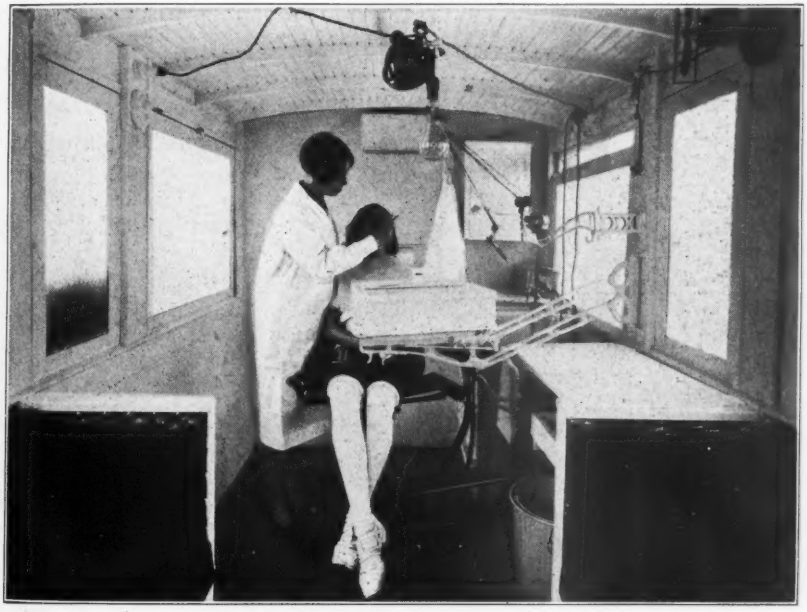

Fig. 2.—San Joaquin County dental unit.

1. Smith, C. C.: Dental Health Activities in Public Schools, J. A. D. A., 16: 2146 (Nov.) 1929.

This is significant of the economic value of dental service in the industrial world in conserving the health of employes.

One of the great questions on health that the American people have to answer today is: How much time do people lose from their usual occupations because of disabling illnesses? This is one of the problems being studied now by the Committee on the Cost of Medical Care and the answer is quoted from a recent abstract released by that committee. It states:

Adult males lose seven to eight days per year on the average and adult females lose eight to twelve days. Of 570,000 people in industrial communities studied by the Metropolitan Life Insurance Company, roughly 2 per cent were ill, on the average, on a single day. This indicates an average loss of time for both sexes of nearly seven days per year. Among the Edison Electric Company of Boston employes, the men lost, on the average, seven days per year and the women thirteen (these figures include Sundays and holidays). The school children of Hagerstown, Md., lost seven days per school year of 180 days and certain Missouri children lost 5.6 per cent of all school days or ten days per school year of 180 days.

In general, therefore, the foregoing data indicate that the 36,000,000 wage earners in the United States lose 250,000,000 work days a year at least, and the 24,000,000 school children lose 170,000,000 days a school year.[2] This economic and industrial loss is tremendous and is estimated to be over 15,000,000,000 a year in dollars and cents. The amazing truth of the situation is that the most of these disabling illnesses are preventable.

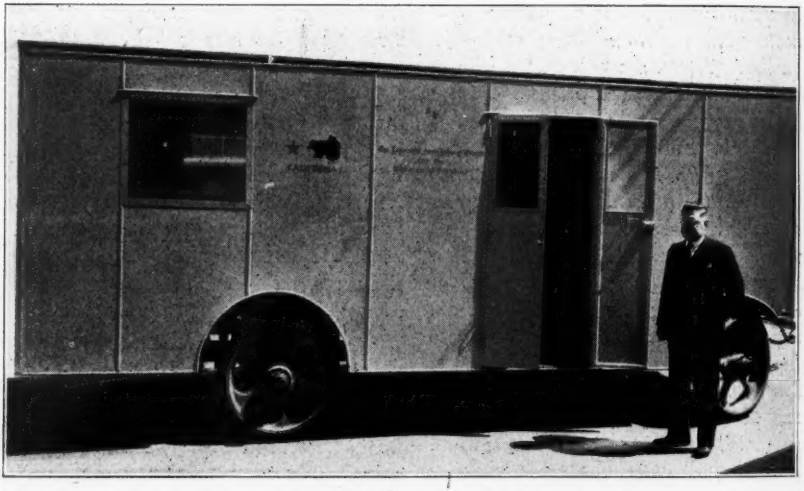

Fig. 3.—Lokrantz dental ambulance used in Los Angeles City Schools.

Examination by the Life Extension Institute of more than 100,000 adult males in the prime of life revealed the following percentages with dental defects: 39 per cent were in need of extensive dental work; 18 per cent had slightly infected gums; 15 per cent had carious teeth and

2. Committee on Cost of Medical Care Report.

septic roots, and 6 per cent had definite cases of pyorrhea. In another examination of 10,000 adult male industrial workers, defective teeth and pyorrhea were found in 6,093.[2] The situation, according to the Committee on the Cost of Medical Care, is that, among school and preschool children examined in six different surveys, from 65 to 95 per cent have one or more defects. In four of the groups surveyed, defective teeth were found in more than 50 per cent of the children, and, in some special dental studies, even higher proportions are shown.

It is highly important that children possess good health during their formative years, and experience has proved that the proper place to reach them, to do the most good, is in our public schools. Our children's first insurance toward sound health came with the school nurse and the social service worker. She paved the way for medical and dental attention; physical education, playground work, and diet and nutrition supervision in our public school system, and the dental hygienist soon followed. Oral hygiene was introduced into the public schools largely through the work of Alfred Fones in the schools of Bridgeport, Conn., about 1914. Such gratifying results were obtained that the movement has extended to nearly every state in the union. There are now forty states having committees on mouth hygiene and public instruction in their state dental society, and the American Dental Association maintains a Bureau of Dental Health Education to cooperate in every manner possible with the school authorities in bringing to the people of our country dental health information.

Fig. 4.—Interior of Lokrantz dental ambulance, Los Angeles, Calif.

Twenty states have full-time state dental workers. These workers are associated with the state board of health, except in Iowa and New York, where their activities are carried on under the direction of the state board of education.

Preventive dentistry in association with proper diet aand nutrition is one of the most important phases of a modern public health program. Statistics from the World War direct public attention sharply to the fact that, in spite of America's being the home of scientific dentistry, dental defects ranked second among the causes for rejection from army service. Think of what this means: Not some serious vital organic disability like tuberculosis, diabetes or blindness, but dental defects were the second most prevalent cause for rejections among the flower of American manhood between the ages of 21 and 30. Unclean mouths, bad teeth, abscessed teeth, septic roots—a picture of willful neglect; a blot on the escutcheon of America's health; and the pity of it was that such a state of affairs can be prevented.

The consequence of this situation, when it was fully realized, was to turn the attention of every dentist, physician, dental hygienist, public health nurse and social service worker from adult health problems to the children in our public schools, with the endeavor, through training and education, to control and prevent such conditions, which lead to so many serious defects later in life. The old saying that the "proper time to begin the education of a child is before its birth," holds true in a health program as well as in the field of education; and thus we find the nation turning the searchlight of science on prenatal care, the preschool child, and the children in the public school, America's most cherished possession.

Therefore, for some years past, and continuing today, such national organizations as the American Dental Association, American Medical Association, American Public Health Association, American Child Welfare Association, American Dental Hygienists Association, United States Public Health Service and many others interested in public health, in conjunction with parent-teacher associations; public service clubs, the Red Cross and community centers, are carrying on definite health programs in the public schools of the United States, in order that the children may be provided with ways and means to grow with not only strong minds, but also sound, healthy bodies.

Your interest, as parents and teachers, is earnestly desired in support of the health workers in the schools of this county. Every one of the organizations mentioned above includes dental care as an important part of its activities and recognize the schools as the proper place to teach the children and do them the most good. Dental care in the public school is not a new idea, as many cities have had such programs for over twenty years. Experience has proved the benefit of dental service to school children later in life, and it is gratifying to see the movement steadily spreading. Schools that do not have some type of dental service today are the exception. To mention some cities that provide dental care for school children, there are Chicago, New York, Cleveland, Peoria, Atlanta, Detroit, Los Angeles, San Francisco, Long Beach, Stockton, Oakland, Sacramento, San Jose, Berkeley and others too numerous to mention at this time.

The school examiners in New York City found that 62 per cent of 266,426 children examined had defective teeth. Cleveland had an average of 5.6 cavities per child, and Andover, Mass., reported

96.9 per cent of the school children with decayed teeth. Virginia set the figures at 85 per cent; and North Carolina at 75 per cent.[3] In San Joaquin County, California, during the past four years, 20,608 school children were examined and 45,000 operations were performed, such as cleaning, extraction, filling and treatment, all free of charge.[4]

The city of Atlanta is carrying on a most successful dental health program. I quote the superintendent of schools of Atlanta, Mr. Willis A. Sutton:

> When I came to be superintendent of schools. . . . I said "I am satisfied that much of what is going on in Atlanta in the way of failure among our boys and girls is due to bad teeth, I wish I could make a demonstration . . . in one school of 987 pupils." I set to work. . . . We examined and cleaned every child's teeth. We tried as rapidly as we could to put every child's teeth in A1 condition as nearly as we could. At the same time, we went at other things like nutrition and home affairs. . . .
>
> Before that year, we had had 32 per cent of the children in that school fail. Before that year, we have had over 3,800 absences from those 900 and more students. I got the complete record, and after their teeth were put in good condition, I kept the record for nine months. By that experiment, we saved 1,200 school days. Each school day is worth, according to the United States Government, depending on the grade, from about $10 up to $40 a day, but putting it down at $10 a day and seeing 1,200 school days lost, you begin to realize what we saved in money. . . . We had 83 per cent attendance in our school system when we started. We have risen to 96.7 per cent average for the entire school year. . . . and we have raised the standard of our schools promotion from 28 per cent failures to less than 8 per cent. We have brought a happiness into the thoughts and minds of the children that is marvelous to see, and just makes your heart glad.[5]

Reports from all over the country show similar results. A great deal of retardation of the average grade school child is due to poor health and much of the ill health is directly traceable to dental conditions. It costs just as much to teach a child the same thing a second time as it did the first, and in the state of California, with a total of 584,968 children in grades from one to eight inclusive, as of March 1, 1924, there were 60,163 "repeaters," i. e., children who were repeating a grade, and 186,202 retarded pupils. The importance of such situations can be emphasized by the cost involved to the taxpayers of the state. "The direct and actual cost of teaching the same grade a second time to 60,163 pupils is as great as the cost of maintaining all the elementary schools in the San Francisco and Santa Clara counties, or all the elementary schools in the Sacramento Valley, or more than five times the entire cost of the state teachers colleges during the year 1923-24," according to Will C. Wood, when he was superintendent of public instruction, of California.[6] Since 1911, the school children of Peoria, Ill., have had the advantage of mouth hygiene instruction; and under the direction of C. Carroll Smith, who has been in charge of the work since 1918, this city is known from coast to coast for the mouth hygiene service rendered its school children. Superintendent of schools, W. L. Stevens, of Long Beach, Calif., is intensely interested in the dental program in the schools of his city and S. Lokrantz, medical director of Los Angeles city schools, and superintendent of schools, Mrs. Susan

3. Public Service Committee of the Chicago Dental Society.

4. Five Years' Progress in Health Administration in San Joaquin County.

5. Sutton, W. A.: Health and Education, J. A. D. A., 12: 273 (March) 1925.

6. Thirty-First Biennial Report of the State Superintendent of Public Instruction, p. 80.

M. Dorsey, are sponsoring an oral hygiene movement in the Los Angeles city schools under the direction of city dentist, Verne L. Wilt. Dr. Lokrantz has successfully instituted ambulatory clinics for use in the outlying districts of Los Angeles since 1925, and last month, under the direction of a committee, one of these ambulances, named "The Lokrantz Ambulatory Clinic," was equipped and shipped as a gift from Americans of Swedish descent, health workers of Los Angeles, Carl Curtis School, the dental and medical professions and others interested in child welfare to the children of Norrland, a remote district in Sweden, that they might benefit from our own modern crusade for child health.[7]

The city of San Francisco, under the direction of William Hassler, city health officer, and Robert Grosso, city dentist, are carrying on a dental health program with the services of from ten to twelve dentists and several dental hygienists supported by the city and county of San Francisco and caring for thousands of children each year.

In the state of California, more than fifty dentists and thirty-five dental hygienists are estimated as engaged in schools, hospitals, community centers and clinics. San Joaquin County, California has a splendid health unit organized under the name of the "San Joaquin Local Health District," comprising the cities of Stockton, Lodi, Tracy, and Manteca, which includes a highly satisfactory mouth hygiene service for the school children of these cities with two dentists on the staff. John J. Sippy of Stockton is the district health officer. In a recent letter, he states:

> Under the Health District Act, we are a body politic, separate and distinct from other county and city governments, corresponding to school, sanitary, road, or irrigation districts. The district is governed by its own Board of Trustees, and is supported by a separate tax levy just as a school district would be. The Board of Trustees is made responsible for the selection of the Health Officer and he in turn is made responsible for the selection of his staff. Oral hygiene is made the subject of a separate division of work as a part of our school health and development program. The cost of this work in the past five years for each fiscal year, ending June 30, has been as follows: 1925, $7,125.97; 1926, $7,206.33; 1927, $9,099.98; 1928, $8,023.07, and 1929, $7,779.48.

The policies and duties of the oral hygiene division of this health district are as follows:

1. To cooperate with the local dental association in oral hygiene education.
2. To conduct demonstration work in schools.
3. To care for indigents unable to employ private dentists.

All work is carried on by and with advice and endorsement of the local dental association. Demonstration work in schools is limited to children under 12 years of age, or until the appearance of permanent teeth. The service is given free to all applicants, since it is regarded as an educational and not a charitable enterprise. No work is performed without request and consent of parent or guardian. Particular attention is devoted to preservation of the first permanent molar and of temporary teeth until succeeded by permanent ones. Treatments are limited to such as may be performed at one sitting, but include cleaning, extraction, filling and temporary cavity or pulp treatment. Children requiring continued treatments are referred to private

7. Mr. S. A. Coulthard of Los Angeles furnished this information and photographs of the Lokrantz Ambulatory Clinic; Fred T. Foard, acting assistant surgeon, county health work, Stockton, Calif., the Photographs of the San Joaquin Local Health District, Division of Oral Hygiene Unit.

dentists, or if indigent, taken care of at the Stockton Dental Clinic. The latter is conducted in the Hough Memorial Clinic Room at the Stockton City Emergency Hospital from 1 to 5 p. m. and is open to indigents from any part of the county, all of whom, however, must obtain entrance permits from our social welfare worker or investigator.

Work in rural schools is conducted in a dentist's office, fully equipped, mounted on a Graham truck. If the truck is parked in the school yard, work may be carried on without interruption of school work. The dentist in charge is accompanied by a truck driver. A second dentist, who operates in Stockton and Lodi city schools for one-half of each school day, is equipped with a portable outfit. The other half of the day is given to the Stockton dental clinic for indigents. Both dentists devote full-time, on a salary, and are not permitted to carry on a private practice. Women dentists are preferably employed, for several reasons, principal among which are (1) their tactful approach with children, (2) their prefrence for children's work as a specialty and (3) a disposition to remain permanently.

This work has been successfully carried on for the past five years in San Joaquin County and has become indispensable to the health service of the county. To quote from one of the reports of the district, "It is conceded that public health service does cost money—so do fire and police departments. While the latter two serve to some extent as life savers, it must be admitted they are more largely concerned with the protection of property. Property can be replaced—human life cannot. San Joaquin citizens believe in health conservation as a matter of economy as well as of humanitarianism.[8]

There are many other fine programs of oral hygiene being carried on in various parts of the country, but time precludes going into further detail. In conclusion, let me call to your attention the fact that, at the last California legislature, two bills of educational and dental interest were passed, amending Sections 4,225 a and 3,062 of the political code, granting the right to boards of supervisors in cities and counties to employ dentists or dental hygienists in the public schools and pay them from the city or county treasury as the case may be, just as has been done in the case of public health nurses heretofore. The passage of these two bills, alike in purpose, one applying to cities and the other to counties, enables any city or county in the state of California to start an oral hygiene program in the schools by securing the approval of its board of supervisors to employ the dentist or dental hygienist to carry on the work in conjunction with the local dental society and cooperation of the parents, public health nurses, social service workers, teachers and school authorities of the city or county.

An oral hygiene program in the schools proves economy for the county, since it reduces the amount of time lost in school attendance and greatly reduces the number of children repeating grades, as mentioned earlier in this paper.

Nature's greatest gift to mankind is health, so let us learn to conserve it. And as a final work to you as custodians of the physical and educational welfare of the children of Merced County: Lend your every assistance to the health program

8. Review of Operation of the San Joaquin Local Health District, 1923-1928, p. 15.

and health workers in your schools in extending the usefulness and preaching the gospel of prevention through the use of the toothbrush.

DENTAL CLINIC SERVICE IN NEW YORK CITY*

By CLARE TERWILLIGER, New York City

COMING to Massachusetts to talk about dental clinic service as a part of a public health program is like "carrying coals to Newcastle."

This state has long recognized the fundamental things, such as establishment of definite policies and the need for professional advice and endorsement.

Dental clinic service has a definite place, but, in some instances, it is proving difficult to find that place because of two handicaps. Dental work is expensive, and few people realize that its administration is highly specialized.

In making the first survey of New York's dental clinics in 1923 under the auspices of the Committee on Dispensary Development, a number of situations were found which sound funny but are really tragic when given a little thought.

In several hospitals, the superintendent said, "Yes, there is a dental room here and a dentist comes in and works, but I really don't know what he is doing. You go down and see for yourself."

In a settlement house, it was stated that the outstanding need of all children belonging to the clubs of the house was the dental need, so they had gathered equipment that would make a good beginning for a dental antique shoppe, and one of the social workers had got her boy friend, who was a dentist, to come once a week and work in the so-called clinic.

In neither situation had thought been given to the place of the dental service in the organization, the policies about source of patients, age groups, types of work to be rendered and technics.

The chaotic condition found during that first survey resulted in a continuance of the Dental Advisory Committee for another year. Four subcommittees were formed. Additional members were selected, and at the end of the year, a group of thirty dentists and laymen interested in public health published "Tentative Standards for Dental Service in Hospitals and Clinics." One of the conclusions reached by that group was that public dental service, in order to reach the people for whom it is meant and to be of a uniformly high quality, should be promoted by a permanent organization over a period of years. In this way, the work started by a research committee, in the field for a short time, was turned over to the New York Tuberculosis and Health Association. The Committee on Community Dental Service was formed and its chairman became a member of the board of directors.

In the course of the first year, six clinics came under the management of the newly created dental committee. The clinics varied considerably: one was in a public school, one was in a school maintained by private funds for handicapped

*Read at the annual meeting of the Massachusetts Association of School Dental Workers, May 6, 1930.

children, two were in health centers where children only were treated, and the remaining two were being used as an experiment in self-supporting dental service for young adults in industry and clients of social agencies.

The principles of supervision laid down by the committees that worked on the tentative standards were adhered to strictly. As that definition is worth repeating on every possible occasion, it is here quoted again, although some of you have read it.

> The committee wishes to emphasize the great importance of professional supervision, particularly when any attempt is made to develop method and technic. By supervision, the committee does not mean occasional fault-finding inspections or the establishment of a board supervisory in name only. Professional supervision is the regular contact of a consultant or supervising dentist or body of dentists with the dentists who are performing the actual work in the clinics. Professional supervision consists in assuming responsibility for the quality of the work turned out and in availability for consultation; but, more than that, it means a constructive interest in the work, which develops a stimulating morale. Work supervised in this way not only maintains its permanency but also builds for future development. In dental colleges and hospitals, this supervisory service is automatically provided, but for detached dental clinics, it has never been adequately developed.
>
> The committee considers supervision of so much importance to the efficiency of work done and to the morale to the clinic that it advocates the abolition of detached pieces of work unless supervision is provided.

In dealing with the personnel of these newly acquired clinics, all sorts of situations arose. There was the dentist who would rather order supplies than practice dentistry and almost seemed to have the point of view that such an activity constituted supervision. There was the young dentist who persisted in doing "thumb amalgams" with faulty preparations and who resented supervision. There was the hygienist who refused to do anything but scale and polish teeth and who required a lot of service to do that. Worst of all, there was the lay person who brought or referred patients to the clinics and who felt capable of criticizing the dental work.

The first step was to draw a sharp dividing line between administration and technical work.

The dentists did nothing except dental work and the recording of their operations on the charts. The administrator was responsible for everything else and had to be efficient to be economical. The only member of the personnel who combined technical and administrative work was the hygienist who was asked to supplement the work of the administrator.

In order to have a basis for supervision a "Standard Procedure for Treatment of Dental Clinic Patients" was worked out. This procedure outlined what was to be done the first time the patient sat in the clinic chair; the second time, and at subsequent sittings. It indicated what cases required the final decision of the supervisor. After three years' experience with this procedure, the entire dental committee and all the operators contributed to a revision, which has just been published.

Time has been taken here to sketch this history briefly to emphasize the fact that efficient management means a careful definition of jobs and that a highly specialized activity such as a dental clinic requires efficient management to be economical. Everyone engaged in such work has a public responsibility to operate a clinic as cheaply as possible, but, at the same time, to insure a quality of service which will contribute to the good health of the patient.

With an exact procedure and excellent supervision, the technical work will fall

down if the administration does not make definite appointments for all patients and make every effort to see that the appointments are kept. If the dentist knows that he can work for a half hour on each child without interruption, he can accomplish more and better work than he can when he is harassed by someone at his elbow reminding him that there are still fifteen children in the waiting room.

There are still clinics where the time of each appointment depends on the size of the horde that appears during clinic hours. At 10:30 one morning last winter, a worker arrived at a dental clinic with thirty children. The clinic session was supposed to close promptly at 12:00. There were two chairs and two operators. The dentists were told that all these children had to be seen. An hour and a half with two operators makes 180 minutes of operating time. That allows six minutes per child, including the time for the dentist to wash his hands. That leaves just about time for a look and nothing else. It seems to me that this kind of management is evidence that there are still people who feel that large numbers on a monthly report sheet are the goal of dental clinic service. It would be better never to write a report than to have on one's conscience the indifferent dental work and its psychologic effect on the young dentist, the waste of time of the social worker or nurse who brings the children and, most important of all, the danger to the child's health and the false confidence which parents have because their children have attended a clinic.

In 1928, the Dental Committee of the New York Tuberculosis and Health Association made a second survey to check up on clinic conditions. Isolated clinics were still springing into being and dying out as suddenly because of the chronic lack of planning. The department of health situation had not changed. There were clinics in nineteen public schools and New York City has more than 700 schools. Years ago, a group had started with the slogan "a dental clinic in every public school." When nineteen were established, the budget failed to increase. Since that time, a study of economic conditions has created a changed point of view. The dental work is being confined to children in the kindergarten to 2B grades inclusive in the poorest sections of the city. The work of the hygienists takes in the grades up to and including 4B and is being increased as fast as funds will permit, because education in mouth health is needed everywhere, regardless of the economic plane.

A dental clinic service is useless without coordination with an educational program. Mothers and younger children cannot be reached easily. The line of least resistance is to treat school children. They are herded together and can be worked on with ease. To cut down the amount of work needed by each one, they should be reached earlier.

With the old emphasis on the clinic phase of the program, those engaged in the work are apt to start with that thought in mind but forget about it when they become swamped with the need of those easily accessible.

The coordination of the educational and clinic programs is going to be difficult. It has advanced far in some places and is not started in others. Dr. Oberteuffer of Columbus, Ohio, said, at the Chicago Dental Society meeting in January of this year, that health instruction does not have the same recognition as the older academic subjects, and that no state requires it at present for graduation from high school, although in some places it may creep in through physical educa-

tion which is a recognized credit. In summarizing, he states that, in the first six grades, health should be taught by classroom teachers; in the remaining six grades by special teachers in a specific course. Correlation with other subjects, he says, is desirable but unreliable as sole agent; all elementary school teachers should be required to have an understanding of teaching health and school health problems, and research, not empiric judgment, is the only reliable basis for development of subject matter.

There is an appalling need for the development of subject matter and exact definition. The lay mind is constantly confused by talk about "preventive dentistry" which to some people means filling pits and fissures; to some, any dental work for children; and to others, the regulation of the diet of the expectant mother to build strong teeth. There is more confusion over the so-called 100 per cent mouths. There are probably as many definitions as there are people using the term.

In the midst of this transition period, Mr. and Mrs. Murry Guggenheim, in June, 1929, announced their gift of dental service to the children of New York. It will not only result in a great service which is sorely needed, but also will aid materially in working out the many problems which face those who feel the need of proper instruction in mouth health and the attendant service which will put the mouth in a healthy condition.

An experimental clinic which serves as a sort of laboratory to the executive group of the Murry and Leonie Guggenheim Dental Clinic has been operating since Dec. 9, 1929. It serves one public school with a population of 1,125 pupils.

The "Standard Procedure for Treatment of Dental Clinic Patients" which has been mentioned before has been adopted for the guidance of the dentist and hygienist. As questions come up, they are discussed by the executive group, and policies are established.

The reports are studied and plans will be drawn up for the kind and extent of all phases of technical work as well as social service and health education.

Much of the success of the clinic so far has been due to the fact that the dental work has been made a part of the school curriculum instead of something extra which disrupts discipline.

An effort has been made to make the clinic rooms look as though they were intended for children so that they will feel that the place is theirs.

Most clinics are rooms full of machinery to the small child. An appearance of thought for him, expressed by small chairs, bright colors and interesting decorations, has a psychologic effect which cannot be measured. There is the difference between the stubborn "I won't," based on no reason, and "I'll try it," also based on no reason.

According to the procedure adopted, the first service rendered the patient is prophylaxis. This places the responsibility for the first contact and the foundation for future dental health education on the hygienist.

A few years ago, Dr. Quinby said: "Work of hygienists divides into two parts, public and private, each having the same subdivisions, educational and practical." I would modify that further, dividing the work of the hygienist into (a) public and (b) private office and clinic. Under "public," the subdivision "education" would be all important, with the "practical" or actual scaling of the teeth reduced to the minimum necessary for demonstration. Under "private office and clinic," I should place "practical"

first and regard "education" as incidental. I do not mean to minimize the educational value of the teaching a hygienist can do while cleaning the teeth; rather, I want to emphasize the importance of her imagination and keen perception to notice and capitalize the things about the individual's own mouth which will make a lasting impression.

The applied knowledge of his own mouth conditions is an invaluable adjunct to the general health education of the patient that is being carried on by departments of health, voluntary public health agencies, boards of education, and the advertising campaigns of commercial agencies to present their mouth toilet preparations to the public.

All of us in public health work have had to realize that experiences in other parts of the country do not capture the imagination of a community in trying to impress the citizens with the importance of a mouth health program as does the exact information about their own children's teeth. If you can say to a group, "Every one of your children between the ages of 2 and 12 has seven cavities," each father or mother will be aroused, but if you say, "Every child in California has seven cavities," the reaction is apt to be, "Well, isn't that too bad?"

The preparation of the two groups of hygienists is essentially different, and the educational group is necessarily the smaller group.

From the standpoint of dental clinic service, the hygienist needed is one who has had an intensive course in technical procedure, with careful training in the relationship of mouth conditions to general health. Such a course requires practical teachers who lose no opportunity to emphasize the relationships and their teaching value in the every-day practice work required in the intensive course.

The public health course might well be offered in a few institutions of recognized academic standing, with a certain amount of credit allowed the hygienist who has had the technical course and has evinced an aptitude for organization and administration which would warrant the additional training to prepare her for an executive or teaching position in the field of mouth health education.

During the last few months, a number of people have said in my presence that the field of the hygienist is limited and that a sufficient demand does not exist to warrant opening any more training schools. That question opens up a subject for an entire paper. I shall not go into it now, but I should like to suggest to those people who have made such statements that their eyes have possibly been closed to the great field of the hygienist in hospital work, which has scarcely been touched but has been unquestionably proved in a few isolated instances.

Much has happened in New York City during the past few years to further dental welfare. The interest of a public health organization such as the New York Tuberculosis and Health Association has produced a standard of measurement for the efficiency and quality of clinic work; the department of health has adopted its policy to attack the dental problem early and to apply preventive dentistry through education and the dental hygienist. When the number of children needing dental care and unable to afford it seemed too large for the present public machinery, the gift of the Guggenheim Dental Clinic was made. This clinic, planned with great foresight, is asking the help of those whose experience best enables them to guide a public health program in dentistry, and is profiting from the development since 1923 of a professional sense of responsibility toward

public health on the part of outstanding private dentists. While the Guggenheim program includes complete corrective dentistry, its plans for the training of hygienists to teach and practice preventive measures looks forward to the day when regular care and systematic education of the public will have done their part toward the elimination of much unnecessary dental disease.

SCHOOL DENTAL SERVICE IN GREAT FALLS, MONTANA

By A. S. CHICHESTER, D.D.S., Great Falls, Mont.

IF the process of dental decay and the subsequent attendant destruction of the pulp tissues with their bacterial involvement were less serious in the mouth in childhood than in adulthood, the seriousness of dental ill health among children of school age might be a debatable question. That this process is identically the same at any age as far as resultant disease is concerned is, I think, quite generally accepted. Regardless of what theory is advanced as to the predisposing causes of dental caries, it can hardly be argued that the pus organisms or toxins produced thereby in a child's mouth are less harmful than those found in the mouths of grownups. It is common knowledge that decay is becoming increasingly prevalent in young mouths, and so if the delicate anatomy of the temporary tooth is considered, it is readily seen that the destruction of these little teeth is comparatively rapid. Therefore, caries in the tooth of an adult that might take two years or more to produce pulp destruction could and usually does produce this sequel in the young tooth in six or eight months.

If bacteria and their toxins are the cause of a high percentage of serious physical disturbances in adult life through metastatic infection of dental origin, is it not reasonable to assume that similar metastasis in the mouth of the young is equally serious? Aye, much more serious? Our life insurance companies tell us that the older an individual becomes, up to a certain age, the greater is his expectancy for future useful years. They have a logical reason for it. As the child grows and develops, if he gets through the early years—say, to puberty—without having been beset by the unseen foes, contagion and infection, the foundation stones are well and strongly set and become increasingly resistant to external destructive forces.

It has been said that "the things we value most lie closely about our feet." The very commonplaceness of many of the problems that present themselves in the course of human relationship and social intercourse often militates against their solution. The obvious solution to these problems—many of them fundamental—often passes unheeded, until suddenly there is an awakening, and we wonder why the matter escaped our attention so long. There is a flaw in the beam. We guess that it must always have been there and probably always will be. Too often the structure must collapse

and the ruins stand an eloquent memorial to our shortsightedness and inertia before our responsibility is clearly seen.

Few schools nowadays in the larger towns and cities but carry out at least a cursory program of physical examination, either through their own school physicians or through the local board of health. I think it would be safe to say that practically all of these examinations include the mouth, yet to comparatively few has it occurred that quite obviously an oral examination made year after year without something being done to correct the condition usually discovered to exist is both useless and a waste of time. So, if a public, cognizant of the seriousness of this condition, does nothing about it, there must be a reason. There is a reason which I think brooks no argument. It is this: The public is not truly cognizant of the seriousness of ill health in the oral cavity. Generally speaking, there is the flaw in the beam. The importance of early dental care in the mouths of the grammar school children is not appreciated. Parents must be educated with and through their children if public health is ever to mean anything. Primarily, prevention must be the key note and that through a continuous process of education. From where may such information more properly emanate than from the usual source of primary education, the public school?

Great Falls, Montana, is a city with an estimated population of between 35,000 and 40,000, 5,000 or more of whom attend school. A cross-sectional inspection of the general health conditions, mouth and otherwise, of these children during the past ten years would probably show a condition no better nor worse than those of a similar community in Maine or Georgia or Arizona. An effectively functioning teaching staff has been the continual rule, working harmoniously under the guidance of superintendents ever alert to the necessities of a progressive educational system. To this corps may be added a decidedly thorough and health-minded individual in the person of a city-county public health officer possessing outstanding attainments for such work.

The usual physical examination was made in the schools once each year by the health officer and the usual high percentage of bad teeth noted. At the end of each school year, a published report disclosed this general mouth condition as the worst defect, and so it went on from year to year until it became quite apparent that unless something was done, it was hardly worth-while taking time to make an oral examination.

At a meeting of the local dental association, it was proposed by Thomas Walker, the city-county health officer, that a school shown to be in the worst condition dentally be selected and completely taken care of by volunteer dentists who were willing to lend a hand; this, of course, after the matter had been placed before the superintendant of schools and the board of trustees and their consent obtained. The volunteer workers then undertook the task with the understanding that if it seemed worth while, the school system would equip and maintain a room in each school building where the good work might go on under a suitable plan, yet to be decided on.

Needless to say, the work was enthusiastically undertaken by the volunteer dentists and the outcome was that a room in each grammar school was provided with gas, water, a waste system and simple conveniences common to any health room. A single chair, engine and cabinet (second hand in this case) were procured by the city-county health depart-

ment and moved from school to school as rapidly as the work was completed.

In accord with the thought that it was best to undertake a program of correction as well as of prevention, a full time dental surgeon was obtained to be paid by the city-county health department. The school authorities agreed to employ an assistant, or dental nurse, to work with the dentist during the first year. During the next two years, the school employed two more nurses, whose duties included giving increasingly more time to the dental department.

The corrective program undertaken by the school dentist included care of only temporary teeth and in the first five grades, a period in the life of the child when the teeth are most susceptible to decay; also a period during which good or bad habits are most readily formed. The care of the teeth in the first five grades was all that one operator could handle effectively. This operator made a mouth examination of the children in all the grammar school grades, as it was thought that the information obtained from mouths in the three upper grades would make it possible to cooperate with the parents in having the necessary work done by their family dentist.

I will briefly outline the plan as it was put in force in our schools at the beginning of the school year in 1927.

The school dentist, having made a complete mouth examination of all mouths and having charted them, sent a notice to the parents by the child. This notice, sent only to the parents of children up to the sixth grade, explained the necessity of immediate dental attention and urged them to send the child either to the family dentist or to the school dentist. If the family dentist did the work, a record card was provided him to sign on the completion of it, this card to be returned by the child to complete the school record, which was filed with the child's scholastic record.

If the school dentist does the work, it is explained that a registration fee of one dollar must accompany the application for admission to the clinic. It was further explained that the dollar paid in no wise covers the cost of the operation but merely represents an effort to make the clinic self-supporting and hence lighten the extra burden on the budget of the health department. (To date, it has not been quite self-supporting but nearly so.)

In the clinic, prophylaxis, treatment by silver nitrate, cement and alloy fillings, and extractions are taken care of and the general condition of any permanent teeth present is noted. It is to be deplored that the first permanent molar has not been taken care of as yet. Lack of time is the main reason for this, although a "hands-off" policy in the care of permanent teeth by a school clinic has something to do with it. The wisdom of this policy is still undecided, but it is our sincere hope that the first permanent molar will soon be included in the care of the deciduous teeth. Of course, with the clinic going on during the time school is in session, the assistant calls one child after another as the list of "paid in" applicants indicates, until the close of the day at 4 o'clock. From 4 to 5, the day's records are posted and, most important of all, emergency cases from any and all schools in the city are taken care of. Saturday mornings are also reserved for these special cases.

To those children who do not respond to the initial request that the needed dental care be sought, a second reminder is sent, this being followed by phone calls by the school nurse assigned to dental clinic duty and personal house calls where necessary. It might be well to say at this

juncture that the follow up work done by the nurse is the thing on which the success of a dental clinic as a reparative unit depends mainly. Nothing is more effective than the sympathetic understanding that may be engendered in the minds of parents through personal contact made possible by an efficient school nurse, which, after all, is the most hopeful aspect of this whole work, since it indicates clearly that just as soon as the parents are made to appreciate the importance of oral health, their cooperation in most instances is assured. We are particularly fortunate in having two nurses whose capabilities in "follow up" work are decidedly outstanding.

The parents of those children requiring dental care for permanent teeth also receive repeated warnings of the seriousness of neglect of the teeth and the importance of immediate care is stressed. This phase of the work has been rather neglected owing mainly to lack of time. The presence of considerable contagious disease during the past year or more has occupied much of the time routinely devoted to "follow up" activities, which, of course, has been a serious handicap. The rather crowded condition of the schools naturally complicates the situation, which will soon be relieved by the completion of a new building. These temporary obstacles only impede the progress toward a worth while objective. The ultimate goal need never be in doubt.

The program as outlined has been in operation for two years and a half and, at this writing, is showing most gratifying progress, the number of children with unattended dental defects becoming fewer from day to day. When the existing defects in these little mouths have actually been taken care of, even though to a limited degree, and plans have been definitely outlined for a continuance of the corrective program, it becomes increasingly easier to further the main part of the program, the preventive or educational side. Obviously, a preventive program in mouth hygiene is an educational process, the logical source of which is our chief educational unit, the school. The school dentist talks to the patient, during his short visit to the clinic, regarding mouth health and the necessity for regular brushing and repair. It is likewise the school dentist's business to visit the school room occasionally, giving short talks on the importance of dental care. This may be of value to the teachers as well, particularly in enlisting their interest in the welfare of the child's health. Not only that, it may call the attention of the teacher to the condition of her own mouth. A teacher, careless of her own mouth hygiene, is very apt to show little interest in the mouths of her charges.

The school nurses are also a valuable link in the dental educational chain. Particularly among the parents, both by home visits and at parent-teacher meetings, are their mouth health talks made effective. With us, lack of time again has been the chief hindrance in developing the educational side of the program, but it is hoped that this lack may soon be provided for.

Bulletins on mouth health issued by the superintendent to the teachers at intervals are of the utmost importance and our "chief" has found them effective as an adjuvant to the health program. Needless to say, unless the school authorities are themselves interested in the work and ever ready to promulgate it, there is little hope for its success. With their assistance and initiative, the success of the program is assured. Patience, persistence and the maintenance of the interest of the pupil will then do the rest. Truths

concerning mouth health will bear repetition, which is the simplest of all educational processes.

Through the good offices of our local broadcasting station, K.F.B.B., the school dentist, Dr. Bellingham, gives short mouth health talks at 1 o'clock each Monday. This is just another means of reaching the parent through this most modern invention. This parent may neglect his own health, but he has no right to neglect that of his offspring in this day and age.

Last but not least, it is quite important that the interest of the local dental clubs be enlisted in the success of this enterprise. In a questionnaire sent to the teachers at the close of the first year of our school clinic, to find out if possible the reasons given by the parent for not having the child's temporary teeth cared for, the outstanding reply was, "The temporary teeth will soon be lost anyway, so why bother them except to pull them when they ache?" I'm sure that reply was not original. Dentists collectively know that such a statement is not borne out by the facts. Some dentists are lazy. Others do not care to work on children. I have no quarrel with the latter, but I must insist that the man who does not desire to practice children's dentistry must at least be honest with his patient, who trusts him. Such "dog in the manger" tactics have no place in professional life.

To delineate those improvements in the health of school children definitely produced by a mouth health program is decidedly difficult. Particularly is this so when such a program is carried on concomitantly with other equally important health improvement measures. In our school system a high percentage of infected tonsils, sinuses, etc., are given attention. Elimination of defective vision and hearing, and orthopedic corrections, are emphasized and in most instances given attention. Hence, to say with any degree of accuracy what effect the mouth health improvement alone had on the general health of those affected by the program is practically impossible. It would be more accurate to state that the following improvements noted were decidedly influenced by the mouth health improvement.

In 1927, when the program was inaugurated in the first five grammar school grades, the incidence of dental decay was about 80 per cent. In 1929-1930, at the beginning of the school year, oral examination showed that 60.9 per cent of pupils had one or more decayed teeth. At the present time, nearly the end of the same school year and after nearly another year's clinic work, the percentage of decay stands at 30.5 per cent.

In the beginning, that is, in 1927, initial examinations showed that about 12 per cent gave evidence of having had dental corrections made. At the present time, 68.3 per cent have had dental work done, in and outside the school clinic, divided as follows: 43.3 per cent in the school clinic and 23 per cent by private dental surgeons.

Of this 45 per cent cared for in the school clinic, it is safe to say that at least 40 per cent would not be cared for at all if this corrective service was not available. This fact seems amply to justify the existence of a restorative branch in the program, at least during the first few years of its operation.

In a survey of 500 children taken at random throughout the various schools, 85 per cent own a toothbrush and 50 per cent state that they use it at least once a day. It is our plan, in this connection, to place toothbrush drills prominently in

the program of our kindergarten activities at the beginning of the ensuing year. Such early influence must bear fruit.

It is also interesting to note that in 1926 our health records showed that 4 per cent of all school children were affected with some form of heart disease. Recent examination showed a decrease in this most serious of all defects to 1.6 per cent.

In one school—incidentally, one whose principal is most enthusiastic in securing a high percentage of dental correction—out of 292 pupils examined, 112 were treated by the school dentist, thirty-nine by the family dentist, which leaves seventy pronounced O. K. and seventy-one not treated for one reason or another.

In another school, during the first year that the clinic was in operation, 100 per cent dental correction was obtained, and this in spite of the fact that a large percentage of the pupils came from families where indifference to all branches of hygiene was more apt to be the rule than the exception. Here, as usual, keen interest on the part of the principal and teachers, plus an active "follow up" by the school nurses, was responsible for this splendid result.

In conclusion, may I say that no factor in the promulgation of school activities can logically supersede the health factor? That oral health is outstandingly important in this connection may not be gainsaid. Two things are primarily important to the success of any undertaking: first, an abiding interest in its value, and, secondly, an active cooperation on the part of those directly interested.

THE DENTAL HYGIENIST, HER TRAINING AND VALUE*

By CHARLOTTE KLATT SULLIVAN†, Philadephia, Pa.

IN most of the courses training young women for the dental hygiene field are found the following subjects: anatomy, thirty-two hours; physiology, twenty hours; general hygiene, thirty-two hours; oral hygiene and prophylaxis, thirty hours; health administration, sixteen to thirty hours (some schools include child hygiene and pedagogy in this course and have sixty hours of lectures); dental physics, eight hours; materia medica, twelve hours; bacteriology and pathology, thirty hours; chemistry, sixteen hours; nutrition, sixteen hours; tooth morphology or human odontography, forty hours; oral surgery and communicable diseases, eight to sixteen hours; surgical technic, six to ten hours; orthodontia, six to ten hours; radiography, ten hours; histology, twelve hours; oral hygiene talks and practice toothbrush drills, ten hours.

These lectures, with from 125 to 140 hours of manikin practice, 300 to 400 hours operating at the chair; assisting in the oral surgery, extraction and x-ray departments, and practice in meeting and

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assigning patients, gives the dental hygienist a good background before she comes to the dental office.

Some of the schools giving the courses for the training of dental hygienists are: Forsyth-Tufts Dental Infirmary for Children in Boston; Columbia University, New York City; Rochester Dental Dispensary, Rochester, N. Y.; University of Pennsylvania and Temple University, Philadelphia, Pa.; University of Minnesota, Minneapolis; Marquette University, Milwaukee, Wis.; University of Michigan, Ann Arbor; Northwestern University, Chicago; University of California, San Francisco; University of Southern California, Los Angeles; University of Tennessee, Memphis; the school that Dr. Adair started last year in Atlanta, Ga., and now Georgetown University. The universities of Minnesota, California and Southern California and Tennessee give two-year courses.

The cost of taking the course varies from $1,000 to $1,500 or more. Not many girls who are not sincere about the profession of dental hygiene will put in this amount of money and the year to two years of hard work and study.

Since the profession came into being, various fields have claimed the dental hygienist and, with few exceptions, she has always fitted into the scheme of things admirably. The public school systems throughout the country are beginning to recognize the valuable service she can render by teaching mouth hygiene and doing practical prophylaxis. Industry is beginning to realize that the dental hygienist is a real time and money saver, teaching proper mouth habits to employes and stimulating these employes to have necessary corrective work done.

From a material standpoint, the greater number of hygienists are found in private offices, with the exception of Pennsylvania, where the dental hygienists are more numerous in the public health field than in dental offices. This is due to a clause in the Pennsylvania law regarding the practice of dental hygiene, which requires that a graduate dental hygienist, after passing the state board examinations, must give at least eight months of work in the public field.

The value of dental hygienists in public school work cannot be overestimated. An ideal situation would be to have one dental hygienist to approximately every 1,500 school children, and I am optimistic enough to believe that this ideal will eventually be realized. My reason for making that statement is that, to my knowledge, several school boards after employing one dental hygienist have increased the staff as rapidly as possible to give all of the children in their districts the benefit of this work.

The dental hygienist in the public schools occupies a peculiar and effective relationship to the school children. She appears in the classroom as a dramatic interruption to the children's routine school life. Her white cap and gown immediately commanding interested attention, she is given the opportunity to get her message over in much better fashion than parents or teachers can do. She is trained to give health talks and toothbrush drills.

She also has proved very influential in stimulating children to visit either school dental clinic or private office to have necessary corrections made, using her knowledge of child psychology to bring this about. To mention some of the plans she uses: Arrangements are made with local picture theater proprietors to give each child bringing a certificate from his dentist, indicating all corrections completed, a free ticket to the movies. In some other communities, she has the

assistance of the superintendent of schools and is able to offer as a prize to the children having teeth completely cared for a half holiday, and, in still other places, when a room or school building gets 100 per cent on the dental honor roll, there is a class or school picnic held.

I think you will readily see how, by the above mentioned and other similar methods, the individual child is inspired to earn the right to participate in any unusually pleasant activity. By the administration of practical prophylactic care to school children, the hygienist is able to create a feeling of confidence in the young minds by giving them, with her womanly tact and mother instinct, an experience in the dental chair without pain.

School teachers in districts employing dental hygienists are enthusiastic concerning this work. They state that their teaching duties are much easier owing to the fact that the dental hygienist has awakened in the child a more personal interest.

The dental hygienists working in the health departments of industry do very much the same type of service as just outlined for the school hygienist, though of course they are reaching adults.

Even with adults, they employ the dental honor roll idea, urging complete dental corrections and impressing on the workers with whom they come in contact the relationship of a clean mouth to a healthy body, which means greater efficiency and better remuneration in their job.

In the office of the private practitioner of dentistry, the dental hygienist has a wonderful opportunity to be of great service not only to the dentist but also to the people who make up his practice. She is able, with her sympathetic understanding of dental operations, to instil in the patient a confidence, eliminating fear and creating a real enthusiasm for individual dental health. The good hygienist assumes responsibility for the condition of the reception and operating rooms, creating an atmosphere of dignified efficiency, together with an exaggerated evidence of asepsis. In the private office in which the dental hygienist is the only assistant, she relieves the dentist of all office duties, filling the roll of an assistant.

If she is successful as a dental hygienist, she will, in a reasonably short time, build up a busy dental hygiene service and call list from her doctor's clientele. In her intimate professional contact with patients, she tactfully refrains from making any diagnostic statements, referring all such questions to the dentist. During the time that she is giving a prophylactic treatment, she makes an effort to impress on her patients the importance of daily home care of the mouth and proper toothbrushing methods, in a general way making comments on proper diet. In the private office, it has been found desirable to have a separate set of file cards for the dental hygienist's record. According to the idea of the dentist, she has a call list, some patients being called monthly, every three months or twice a year.

A dentist should not consider that, in employing a dental hygienist, he is adding a great deal to his income; but a dental hygienist should prove to be a profitable investment. Practically from the beginning of such a service in a private office, she should pay for herself in actual prophylactic treatments, but the greatest financial return from her work will lie in the fact that she relieves the dentist of his prophylactic work, giving him more time for corrective work. She also is valuable in a private practice in introducing dental service to children in such a way as to conserve both the time and

the nervous energy of the dentist, placing the child in a frame of mind to tolerate the more complicated dental operations.

The average beginning salary of a dental hygienist is about $35 a week. Some dentists employ dental hygienists on a commission basis, with a flat salary guarantee.

To procure a dental hygienist, a dentist should get in communication with the dental hygiene schools. It is hardly necessary to state that when a dentist is contemplating the employment of a dental hygienist, he should be most careful in making a selection. She should be neat and dignified and at the same time of attractive personality.

In equipping an office for a dental hygienist, it is not necessary to have an elaborate outlay. All that is really necessary is a chair, cuspidor, bracket table and cabinet.

The dental hygiene profession has grown steadily from the one state where it originated in 1913, until now there are thirty states licensing the dental hygienist. I predict that the profession will develop into one of the greatest groups of health workers in existence. It can accomplish this only by the continued support and guidance of the dental profession.

MISCELLANY

BOOK REVIEWS

Dietetics and Nutrition. By Maude A. Perry, B.S., formerly Director of Dietetics at the Michael Reese Hospital, Chicago, Ill., and at the Montreal General Hospital, Montreal, Canada. 332 pages; price, $2.50. Published by the C. V. Mosby Company, St. Louis.

This is a compact little volume filled with excellent material. At the end of each chapter, there is a check-up of the chapter called "study helps," which consists of questions in brief form on the outstanding points made in the preceding chapter, thus affording a constant review of the work which is very convenient and comprehensive.

The common sense attitude of the author is well illustrated by the following quotations under the heading "Personal Reactions to Foods": "Many foods contain nutritive value, and yet for some people they are not beneficial but actually harmful. Personal idiosyncrasy may cause even an egg to act almost as a poison to a person; yet we could not condemn the egg and say that it is not a valuable food for most people. Long ago it was said that one man's meat may be another man's poison. Individuals vary as well as foods."

An interesting chapter is the one on "Water and Beverages," and another on "Feeding the Sick." In fact, every chapter makes its appeal.

It would seem that the day had arrived when the dentist is as much concerned in the subject of diet as is the physician, a fact that is apparent when we note the interest taken in this question whenever it is up for discussion in our dental societies. This is only in accordance with logic and common sense, because the factors of diet enter into many of the problems presented to the dentist in every day practice.

We commend this book as a real aid to anyone interested in the subject.

Prosthetic Dentistry. An Encyclopedia of Full and Partial Denture Prosthesis. By Ira Goodsell Nichols, D.D.S., Lieutenant Commander, DC—V(S), USNR Special Lecturer and Instructor in Dental Prosthesis, Dental Department, United States Naval Medical School, Washington, D. C.; with the collaboration of forty-five authorities. 830 illustrations and 3 color plates; 687 pages; price, $12.50. Published by the C. V. Mosby Company, St. Louis.

The object of this book, as expressed in the preface, is to bring the entire subject of prosthetic dentistry under consideration in encyclopedic form in one volume. In furtherance of this idea, the author has brought to his assistance forty-five collaborators who have taken up the various phases of the subject, in some instances in great detail and in others in a very condensed form. To consider a book of this magnitude in its minutiae is manifestly impossible in a brief review, for the reason that almost every chapter of appreciable length would lend itself to extended notice. The names of the collaborators would seem to be sufficient guarantee that the work is well done.

One of the most striking chapters is on "Prosthetic Restoration of Deformities of Face and Jaw," consisting, as it does, of more than fifty pages profusely illustrated. The book as a whole represents a vast amount of work, and the profession is under obligation to the author and his staff for providing another noteworthy addition to its literature.

Personal and Community Health. By Clair Elsmere Turner, M.A.; Dr.P.H., Professor of Biology and Public Health in the Massachusetts Institute of Technology; formerly Associate Professor of Hygiene in the Tufts College Medical and Dental Schools; Sometime Member of the Administrative Board in the School of Public Health of Harvard University and the Massachusetts Institute of Technology; Fellow American Public Health Association; Major, Sanitary Corps, U. S. A. (Reserve). Third edition, illustrated; 443 pages; price, $2.75. Published by the C. V. Mosby Company, St. Louis.

The section of this book having the greatest interest for dentists is, of course, the

chapter on "The Hygiene of the Mouth." This consists of about twenty-two pages, and the subject is as adequately covered as it could well be done in that space. For an author who is not a dentist, the treatment of this subject is well balanced and intelligent, and if this chapter may be taken as an index to the remainder of the book, the volume may be accepted as a worthy addition to our literature.

A really admirable chapter that should prove of interest to every reader is the one on "School Hygiene." The basis of all health problems must be laid in childhood, and school hygiene is an integral part of health conservation among children.

CORRESPONDENCE

The "Dentinocemental Junction"

To the Editor:

I was very glad to read the answer of Dr. Grove (The Journal, August, 1930) to my comments (June, 1930) on his paper on the "dentinocemental junction" (February, 1930). Discussion on a subject which is of interest to one is always welcome. Criticism is never a cause for offense; quite the contrary—we must be grateful for it. A discussion always offers the opportunity for expression of opinions in detail and enables us to cover points that are inapropos in a formal paper. My objection to the use of the expression "dentinocemental junction" at the apical foramen is that we cannot determine this point in any way in clinical work. There is no such thing as a dentinocemental junction at the apical foramen. I refer to a paper by Dr. Coolidge (The Journal, August, 1929) and to other papers on the subject. The illustrations accompanying Dr. Grove's paper are entirely misleading, as he surely can be led to recognize. All the sections in which he shows the "dentinocemental junction" at the apex are oblique sections and, therefore, do not show what they should show according to the statements of Dr. Grove. The tooth, as sketched in Figure 1, may be compared to a tube. The pulp canal is open at the apical end. This is to be seen in every section shown in Dr. Coolidge's paper, as these sections are correctly made, i.e., centrally. If we make an oblique section such as those of Dr. Grove's, we have a picture like that seen in Figure 2; but this does not show the root canal at the apical foramen. Dr. Grove is right: we must fill the root canal to the apical foramen; but let us not say to the "dentinocemental junction," because that point does not here exist. Fill the root canals as nearly to the apical foramen as you can; the nearer you reach this, the better. But you will never be able to find the dentinocemental junction here: no one can, not even Dr. Grove. In Dr. Grove's Figure 4, (August issue, p. 1533), the gold core ends "in the cementum," not at the "dentinocemental junction." The man who is doing scientific work should make no claims that he cannot prove. Dr. Grove states that he is doing good root canal work. He is trying to teach us how to do it, but misleads us by a false interpretation of his microscopic specimens. He *is* doing good root canal work—we recognize that—he is filling his

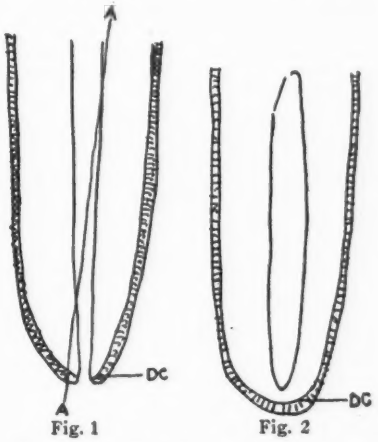

Fig. 1 Fig. 2

Fig. 1.—*A-A*, direction of section of specimen shown in Figure 2. *DC*, dentinocemental junction.

Fig. 2.—*DC*, dentinocemental junction. It is quite evident that this point cannot be determined in clinical work (Fig. 1). The junction here (Fig. 2) is due to the fact that this is an oblique section and so does not afford a true picture.

root canals nearly to the apical foramen—some just to it, some not quite to it, and some, I am sure, beyond it. We cannot tell clinically where the dentinocemental junction is, and, therefore, this point cannot be taken as a guide in our clinical work. We must fill the root canals as nearly to the apical

foramen as we can, the nearer, the better! I wish that other histopathologists and clinicians who are making histologic examinations would state their opinions, or better, their findings, on this question.

BALINT ORBAN,
Vienna IX,
Türkenstrasse 15,
Austria.

July 26, 1930.

GEOMETRIC FINDINGS

To the Editor:

The subject of the geometric finding of the movement of the mandible and its application to the building of articulators and to the articulation of teeth is not so difficult for one to understand, if it were not for the fact that too many meaningless lines and angles have been used, illustrating nothing, confusing the reader and making him feel that he is one of the "dumb."

Fig. 1.—Exaggerated drawing showing error.

Fig. 2.—Correction.

For nearly ten years, possibly more, I have wanted to write something regarding the gross error in the geometric illustrations used in pointing out the rotation centers of the mandible. The author I now criticize is not the only one to make the mistake; in fact, I have seen only one illustration which was correctly made, that of J. W. Needles.

In the August issue of THE JOURNAL, Dr. Gysi, in his Figure 2, has drawn arrows designating point movements of the mandible. These arrows are, in other words, chords of arcs of circles, illustrated nicely in Figure 3. But the error is still found in Figure 3 and in the legend below it. One does not find the center of a circle by drawing lines at right angles from either extreme of chords of different arcs of a circle having the same radius. He should have first bisected these arrow marks or chords, finding the middle, and then drawn lines perpendicular or at right angles to these chords at the bisected points. He would then have found the rotation center.

The exaggerated illustration Figure 1 herewith shows the error. Figure 2 shows the correction.

J. L. HELMER,
4604 E. Tenth St.
Indianapolis, Ind.

RESOLUTION PASSED BY THE BOARD OF TRUSTEES OF THE AMERICAN DENTAL ASSOCIATION AT THE 1930 MEETING IN DENVER

WHEREAS, in "School Health Research Monograph Number III" entitled "Public Health Aspects of Dental Decay in Children," the American Child Health Association has published numerous statements that ignore past dental researches, disregard clinical observations and experience and misrepresent current dental practice; and

WHEREAS, some of the data, opinions, assumptions, conclusions and advice in Monograph III would, if generally accepted, soon undermine present efforts to promote oral health service for children in public schools and under other public auspices, and would also block all new efforts to advance measures for the betterment of child health by oral means; and

WHEREAS, if the unwarranted and careless statements in Monograph III were allowed to stand unchallenged and uncorrected, dentistry would be degraded in public respect and the usefulness of dentistry in public health service in general would be impaired; therefore, be it

Resolved, that the American Dental Association cannot accept as scientific or trustworthy the assumptions and conclusions in Monograph III, for they conflict with the findings of dental researches and with clinical observations and experience that have been recorded by qualified investigators; and further be it

Resolved, that copies of these resolutions be sent at once to the officers of the American Child Health Association and to the Oral Hygiene Committee of Greater New York, to dental, medical and other health service journals for early publication, so that dental, medical and lay judgment on the import of Monograph III may be suspended until a

detailed statement regarding the methods, data and conclusions in the monograph can be published.

RESOLUTIONS PRESENTED AT THE ANNUAL SESSION OF THE AMERICAN SOCIETY OF ORTHODONTISTS, NASHVILLE, TENN., APRIL, 1930.

WHEREAS, a sufficient time having elapsed to permit a thorough investigation into the Arizona orthodontic legislation, which, among other objectionable features, tends to separate the practice of dentistry into limited specialties, therefore, be it

Resolved, that the American Society of Orthodontists in its twenty-ninth annual session goes on record of disapproving any legislative act which permits a state board of dental examiners to issue a permit or license to an applicant for the purpose of practicing a special branch of dentistry who has not first received the degree of D. D. S., or its equivalent, from a recognized university or dental college; be it further

Resolved, that this society heartily concurs in the action of the House of Delegates of the American Dental Association who, during their 1929 Annual Session, approved the report of the reference committee to the House of Delegates in the following words:

"We wish to report that we concur with the report of the Legislative Committee and look with much disfavor on the establishing of a special course leading to an independent orthodontic degree. The specialty of orthodontia has in the past attracted to it students and thinkers who are alive to the best interests of their patients and the profession. They require no special legislation to protect them. The great profession of medicine has not seen fit to give special degrees to those practicing special brands of medicine"; be it further

Resolved, that, in view of the manifested interest on the part of the American Dental Association in the desire to prevent a recurrence of what is known as the Arizona Orthodontic Law, we do heartily offer our commendation and support in such efforts; be it further

Resolved, that a copy of these resolutions be incorporated in the minutes of this society and published in our official journal, and, further, that our secretary be instructed to mail a copy to the Secretary of the American Dental Asssociation and to the Editor of THE JOURNAL OF THE AMERICAN DENTAL ASSOCIATION, as well as to the chairman of the Legislative Committee of the Arizona State Dental Society.

CLINTON C. HOWARD, *Chairman*
W. R. DINHAM,
MAX E. ERNST,
HENRY F. HOFFMAN,
FRANK M. CASTO.

Read and approved in regular session, April 10, 1930. Charles R. Baker, *Secretary,* American Society of Orthodontists.

DENTAL EXHIBIT FOR CHICAGO WORLD'S FAIR

Ingenious dental instruments of such precision have been devised that the lower jaw movements of a toothless person can be measured and recorded, such recordings enabling the dentist to determine the exact forms of artificial teeth that will give the best possible masticating efficiency. It is proposed to exhibit such instruments at the Chicago World's Fair in 1933 as part of an extensive dental display to illustrate dental progress during the last century growing out of the application of scientific methods to dentistry.

Recommendations for the dental exhibit are contained in a report of the dentistry section of the National Research Council Science Advisory Committee under whose directions the exhibits will be staged at the exposition. The section is made up of fourteen dentists.

The main aim of the dentistry exhibit is to educate the public regarding care of the teeth.

Other instruments of precision recommended for display are those for measuring the strength of the bite; for measuring the force required to chew various foods; for measuring the finger power in the use of dental and other instruments; for measuring the shrinkage and expansion of amalgam fillings.

It is planned to have the entire display cover anatomy and histology, physiology, bacteriology, pathology, physiologic chemistry, pharmacology, surgery, physics and metallurgy, anthropology and paleontology.

The National Research Council Science Advisory Committee is composed of about forty leaders in the various fields of scientific endeavor who, under the chairmanship of Frank B. Jewett, vice-president of the American Telephone and Telegraph Company, are collaborating with the Chicago trustees in formulating a science pattern for the exposition.

Members of the dental section of the National Research Council Science Advisory Committee are Arthur D. Black and E. H. Hatton, Chicago; Leroy M. Miner, Boston, Mass.; Clark J. Hollister, Harrisburg, Pa.; Percy R. Howe, Boston, Mass.; Guy S. Millberry, San Francisco, Calif.; Frederick B. Noyes, Chicago, Ill.; Harry W. Nelson, Minneapolis, Minn.; Alfred Walker, New York City; L. W. Morrey, Chicago; U. G. Rickert, Ann Arbor, Mich.; Pearl E. Wilson, Oklahoma City, Okla.; George H. Wandel, and C. N. Johnson, Chicago.

NEWS

The 92 Elements: P. C. Kullman & Co., 110 Nassau Street, New York, have issued a folder containing a list of the ninety-two elements with their names, atomic numbers, symbols, atomic weights, melting points and years of discovery. This is a very convenient folder for dentists to have, and it may be obtained gratis on request by writing the publishers.

Dentist Becomes Missionary: F. C. Scherman, who has practiced dentistry in Oak Park, Ill., for eleven years, leaves soon for the mission field, Kenya Colony, British East Africa. Dr. Scherman has disposed of his practice and has passed an examination for ordination as a minister. He will receive no stated salary, but expects to practice dentistry in his new field. His wife, son and daughter will accompany him.

Portable Playgrounds: In an effort to afford the preschool child, so often jostled about and overlooked in the activities of the neighborhood playground, a place for recreation and sunlight, one of New England's industrial centers has developed "portable playgrounds," which visit different parts of the city on stated days. A side street is closed to traffic and slides, teeters, swings, etc., are set up. Two supervisors accompany the "playground." The only objection to this arrangement lies in the fact that children are led to become more careless about crossing streets, failing to discriminate between their "playground" one day and a dangerous traffic lane the next. The White House Conference on Child Health and Protection is now studying the problem of safe outdoor play space for the preschool child. Reports will be made at the November meeting in Washington.

Deaths

Minton, John Clark, Bellingham, Wash.; Vanderbilt University, School of Dentistry, 1893; died, July 22, after several months' illness, aged 77 years. Dr. Minton retired two years ago.

Taft, Clarence M., Athol, Mass.; Tufts College Dental School, 1917; was killed when a plane in which he was riding fell, at Springfield, Vt.

ANNOUNCEMENTS*

CALENDAR OF MEETINGS

American Dental Association, Memphis, Tenn., 1931.

American Dental Society of Europe, Paris, France, July 29-Aug. 1, 1931.

International Dental Congress, Paris, France, Aug. 3-8, 1931.

Canadian Dental Association and College of Dental Surgeons, P. Q., Sixth Annual Fall Clinic, Montreal, October 16-18.

Chicago Dental Society Midwinter Clinic, Feb. 2-5, 1931.

Greater New York December meeting for Better Dentistry, December 1-5.

Society for the Advancement of General Anesthesia in Dentistry, New York City, October 20.

STATE SOCIETIES

District of Columbia, at George Washington University, Washington, D. C., second and fourth Tuesdays in each month from October to June, inclusive.

September

Maryland, at Ocean City (15-16).

April (1931)

Kentucky, at Lexington (6-8).

New Jersey, at Trenton (15-17).

MEETINGS OF STATE BOARDS OF DENTAL EXAMINERS

Connecticut, at Hartford, November 17-20. Almond J. Cutting, Recorder, Southington.

Illinois, at Chicago, November 18-21. Horace J. Tharp, Secretary, 11112 S. Michigan Ave., Chicago.

Indiana, at Indianapolis, October 27-30. J. M. Hale, Secretary, Mt. Vernon.

Minnesota, at Minneapolis, December 12. W. H. Smith, Secretary, 2337 Central Ave., Minneapolis.

New Jersey, at Trenton, December 1-6. John C. Forsyth, Secretary, 146 W. State St., Trenton.

AMERICAN DENTAL SOCIETY OF EUROPE

The next annual meeting of the American Dental Society of Europe, will be held in Paris, France, July 29-Aug. 1, 1931.

DAWSON BUCKLEY, *Secretary*,
25 Blvd. Victor Hugo
Nice, France.

INDIANA STATE BOARD OF DENTAL EXAMINERS

The Indiana State Board of Dental Examiners will meet at 8 a. m., October 27, at the State House, Indianapolis, in the House of Representatives room, for the purpose of examining all applicants with proper credentials. Examinations will last probably through October 30. Applications should be in hands of the secretary one week before beginning date of meeting. For applications, clinical requirements, and other information address

J. M. HALE, *Sec'y-Treas.*,
Mt. Vernon.

GREATER NEW YORK DECEMBER MEETING FOR BETTER DENTISTRY

The Sixth Greater New York December Meeting for Better Dentistry will be held at the Hotel Pennsylvania, New York City, December 1-5. Among the essayists will be H. E. Harvey, of Norfolk, Va., Stanley D. Tylman, Chicago, Ill., Frank Fox, Philadelphia, Pa., M. S. Weaver, Cleveland, Ohio, W. J. Chartres, Des Moines, Iowa, V. H. Kazanjian, Boston, Mass., W. H. Wright, Pittsburgh, Pa., E. N. Kent, Boston, Mass., and F. Blaine Rhobothom, Chicago, Ill. The meeting will be continued on the same plan as previous meetings; i.e., $5.00 admits members to all lectures, clinics, etc. A subscrip-

*Announcements must be received by the fifth day of the month in order to be published in the forthcoming issue of THE JOURNAL.

tion blank and list of clinics will be ready for distribution November 1. There will be a manufacturers' exhibit in the hotel during the meeting.

JOHN T. HANKS, *Chairman,*
CHARLES M. MCNEELY, *Vice Chairman.*

CANADIAN DENTAL ASSOCIATION AND COLLEGE OF DENTAL SURGEONS, P. Q., WITH THE SIXTH ANNUAL FALL CLINIC

The Sixth Annual Fall Clinic under the auspices of the Montreal Dental Club will be held in conjunction with the meeting of the Canadian Dental Association, October 16, in the Windsor Hotel, Montreal. The clinicians and their subjects are as follows: Albert J. Irving, New York City, cavity preparation; James A. Loughry, Cleveland, Ohio, reconstruction of the mouth; W. A. Grey, St. Paul, Minn., periodontia; Edwin N. Kent, Boston, Mass., economics. The registration fee will be $17, which will include tickets for luncheon October 16 and 17. As the attendance will be limited, those wishing to attend are urged to register with the secretary, M. L. Donigan, 1396 St. Catherine St. West,, Montreal, Canada, as early as possible. The Canadian Dental Association's golf tournament will be held October 15, the day preceding the opening of the fall clinic. Entries should be made at the same time as registration for the clinic.

NEW JERSEY STATE DENTAL SOCIETY

The Sixty-First Annual Session of the New Jersey State Dental Society will be held April 15-17, 1931, in Atlantic City, N. J., at the Hotel Chelsea.

F. K. HEAZELTON, *Secretary,*
223 E. Hanover St.,
Trenton.

SOCIETY FOR THE ADVANCEMENT OF GENERAL ANESTHESIA IN DENTISTRY

The regular meeting of the Society for the Advancement of General Anesthesia in Dentistry is to be held at the usual meeting place, Hotel Buckingham, Fifty-Seventh Street and Sixth Avenue, New York City, Monday evening, October 20, at 7 p. m. Dinner will be followed by two essays: "Some Practical Aids to the Administration of Nitrous Oxide and Oxygen in Dental Practice," by Leonard Orens, M.D., and "Interesting Points in the Relationship of Obstetrician and Dentist," by Joseph Nathanson, M.D.

LEONARD S. MORVAY, *Sec'y-Treas.,*
76 Clinton Ave.,
Newark, N. J.

STATE OF MINNESOTA BOARD OF DENTAL EXAMINERS

The Minnesota State Board of Dental Examiners will hold its next meeting, December 12, at the College of Dentistry, the University of Minnesota, Minneapolis. Applications should be in the office of the secretary by December 1.

W. H. SMITH, *Secretary,*
2337 Central Ave.,
Minneapolis, Minn.

THE EIGHTH INTERNATIONAL DENTAL CONGRESS

The Eighth International Dental Congress, which will be held, August 3-8, 1931, in the Grand Palais des Champs Elysées in Paris, will enjoy the patronage of the president of the republic, and of the government and the leading ministers.

The Organization Committee and the Commissions are already energetically at work. Propaganda committees have been formed in most countries, and the sections receive from these suggestions for the reports and demonstrations to be included in the program.

The demonstrations will be carried out with the aid of the epidiascope, in order to enable a large number of visitors to participate in them.

At the plenary sessions, reports will be given by leading men. Other prominent colleagues will take part in the discussion. The participants in the congress will thus hear an exchange of opinions between the best practitioners. At the same time, reports will be given in the various sections, followed by debates participated in by experts in the line of work under discussion.

The statutes are printed in the four official languages, and their publication in the leading technical periodicals of the dental profession has already commenced.

Numerous declarations of agreement have already been received, or have accompanied subscriptions. The general secretariat for the management of the business, and the treasury, have been organized and have taken up their work.

Many inquiries for information have already been received, and there is every prospect for a well-attended congress.

THE MANAGING GENERAL SECRETARIAT,
45, Rue de la Tour d'Auvergne,
Paris.

STATE BOARD OF DENTAL EXAMINERS OF ILLINOIS

The State Board of Dental Examiners of Illinois will hold the regular fall dental examination, November 18-21, at the School of Dentistry, University of Illinois, 1838 W. Harrison St., Chicago. Reciprocity applicants are required to show evidence that they have been lawfully and continuously engaged in the practice of dentistry for five years or more immediately before filing application to practice in Illinois, that they have maintained a membership in the local, county or state dental society and that the state from which they come will reciprocate with Illinois. Address all communications to The Dental Division, Dept. of Registration and Education, Springfield.

HORACE J. THARP, *Secretary,*
11112 S. Michigan Ave.,
Chicago.

CONNECTICUT DENTAL COMMISSION

The Connecticut Dental Commission will meet at Hartford, November 17-20, for the examination of applicants for license to practice dentistry and dental hygiene, and to transact any other business proper to come before it. Applications should be in the hands of the recorder at least one week before the meeting. For application blanks and further information apply to

ALMOND J. CUTTING, *Recorder,*
Southington.

KENTUCKY STATE DENTAL ASSOCIATION

The 1931 meeting of the Kentucky State Dental Association will be held in Lexington, April 6-8.

J. F. OWEN,
Chairman, Publicity Committee,
Lexington.

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1930-1931

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